

# Altair



Subject: 9th BIOLOGY

Teacher's notes

Class: Specialized Cells  
and Storage

Objectives

Vocabulary

Link and Learn

Date: April 29

Prepared by

# 2011



# Cell's Biomolecules

<http://bit.ly/a5liRR>



# Organic Molecules

<http://goo.gl/bNUxI>

# Specialized Cells

Prepare a 3D Model of the selected cell for your group.  
Your model must show:

- Structural characteristics.
- Labelling of structures.
- Audiovisual presentation about the specialization of the selected cell.

Assessment Criteria:

- Materials.
- Design.
- Scientific Knowledge.
- Oral presentation.

**Deadline: Thursday, June 2nd.**

Group 1

**Skin cell**

CARAVEDO, G  
PINTO, R  
FATULE, N

Group 2

**Sperm cell**

RAMOS, J  
LAMA, Y  
ROSAS, R

Group 3

**Cancer cell**

TORRES DE ALMEIDA, S  
CORBETTO, A  
VILA, V

Group 4

**Liver cell**

CAMINO, J  
PRADO, A  
CABADA, G

Group 5

**Muscle cell**

VILLAFUERTE, G  
GARIBALDI, C  
ZULOAGA, A

Group 6

**Neuron**

TRINT, E  
DONGO, C  
SALHI, S

Group 7

**Egg cell**

REVERDITTO, J  
IBARCENA, M  
VASQUEZ, A

Group 8

**Small Intestine cell**

ROLANDO, P  
MERINO-REYNA, V  
KOGA, J

Group 9

**Macrophage**

COSTA, C  
ACOSTA, R  
ZAPATA, S



# Specialized Cells

Prepare a 3D Model of the selected cell for your group.

Your model must show:

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- Audiovisual presentation about the specialization of the selected cell.

Assessment Criteria:

- Materials.
- Design.
- Scientific Knowledge.
- Oral presentation.

**Deadline: Friday, June 3rd.**

**Adipocyte  
Fibroblast  
Stomach cell**

Group 1

**Small Intestine cell**

ZOLESSI, A  
MALAGA, S  
RUBIO, J

Group 2

**Muscle cell**

VALENCIA, D  
ANDRES, JA  
VIACAVA, B

Group 3

**Egg cell**

COZ, MP  
ECHEANDIA, G  
MAZZETTI, D

Group 4

**Eye cell**

ZAPATA, M  
MONTALDO, Y  
VENEGAS, G

Group 5

**Lymphocyte**

CACERES, C  
JORDAN, D  
CABRERA, C

Group 6

**Lung cell**

CHEESMAN, R  
CHAVARRI, G  
SHIRONOSHITA, S

Group 7

**Cancer cell**

FATULE, N  
PAREDES, MP  
CALVO, MF

Group 8

**Sperm cell**

MELGAR, A  
ROBLES, P  
VALDEZ, C

Group 9

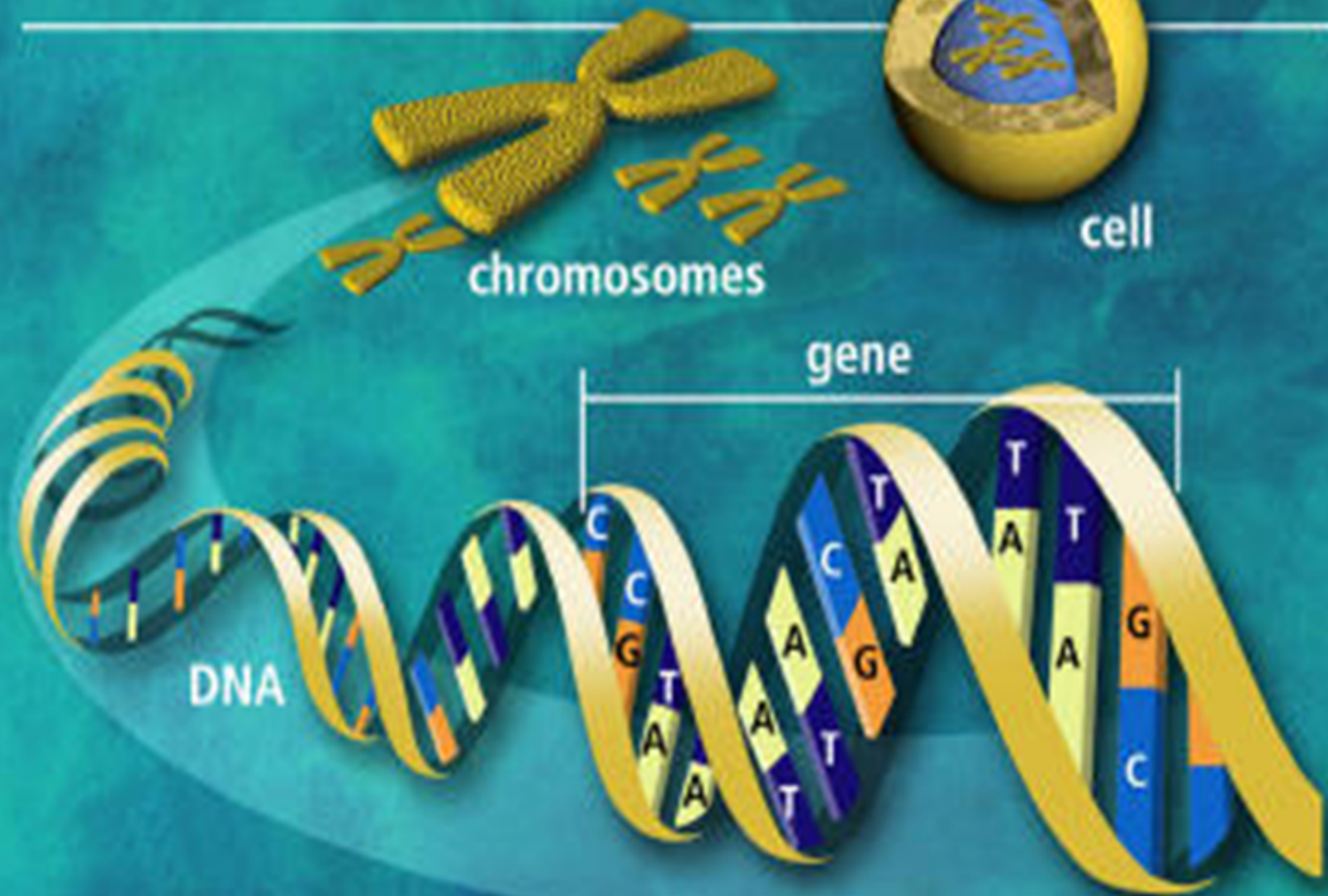
**Heart muscle cell**

GONZALES, L  
LIMONCHI, B  
DIAZ, JA

# DNA

- Inherited characteristics are determined by genes, and genes are passed from one generation to the next.
- Genes are parts of chromosomes, which are structures in the nucleus of most cells.
- Chromosomes are made up of protein and DNA.
- DNA = **D**eoxyribon**n**ucleic **a**cid
- DNA is the genetic material, the material that determines inherited characteristics.

# DNA the Molecule of Life



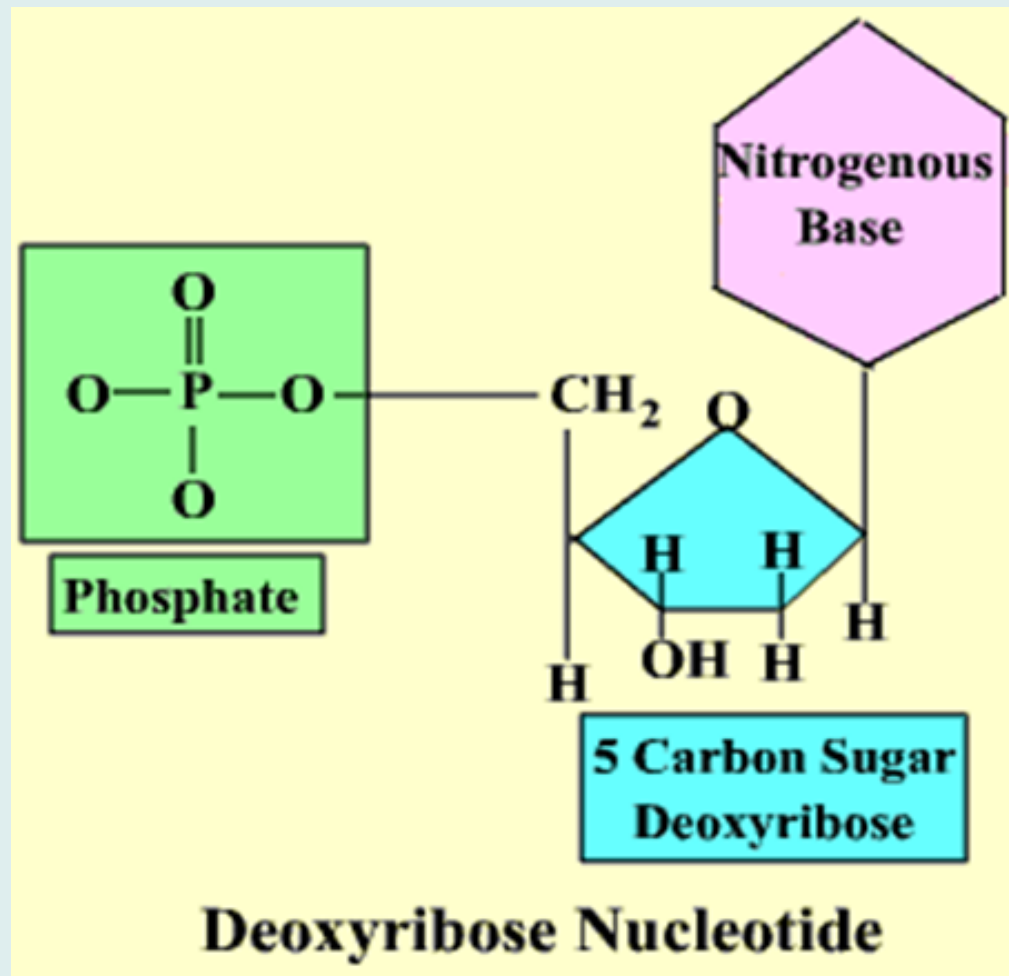
# *What does DNA look like?*

- Scientists knew that the genetic material was able to do two things:  
1st: It had to be able to give instructions for building and maintaining cells.  
2nd: It had to be able to be copied each time a cell divides, so that each cell contains identical genes.
- Scientists thought these things could only be done by complex molecules, such as proteins. Because proteins were considered highly complex molecules since those times.

# **DNA Structure**

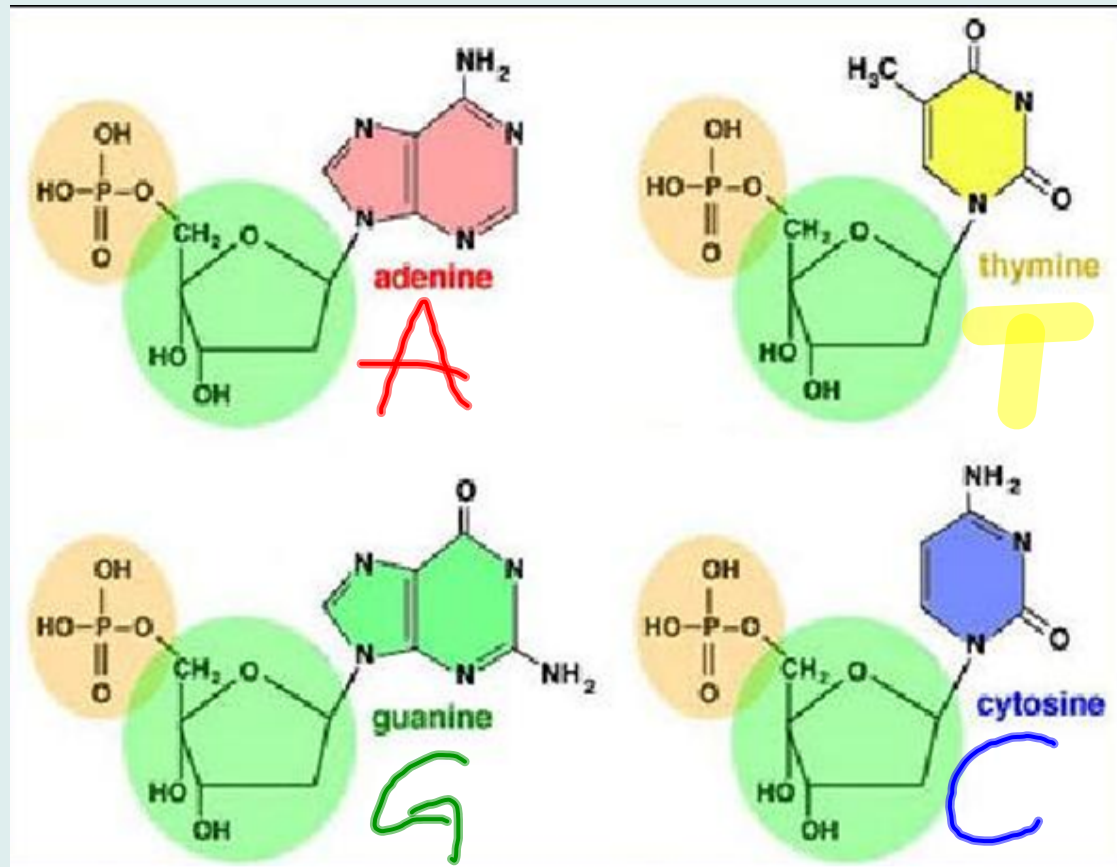
## **Nucleotides: The Subunits of DNA**

A nucleotide consists of a sugar (ribose), a phosphate, and a base.



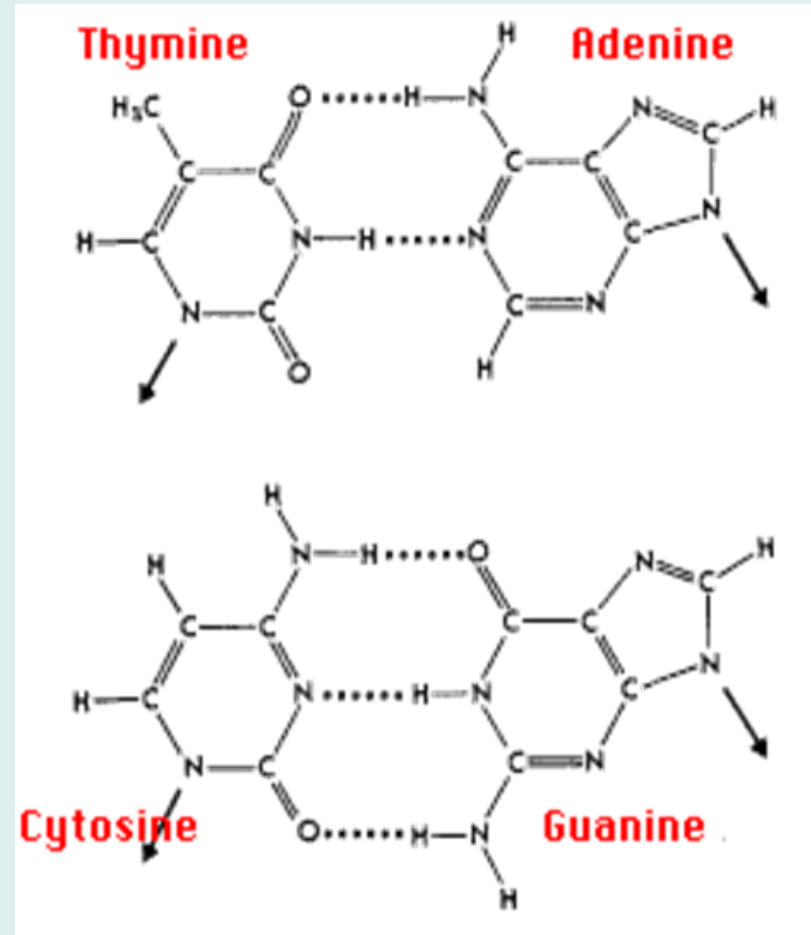
## *Nucleotides: The Subunits of DNA*

The nucleotides are identical except for the base. The four bases are ***adenine***, ***thymine***, ***guanine***, and ***cytosine***. Each one of these has a different shape



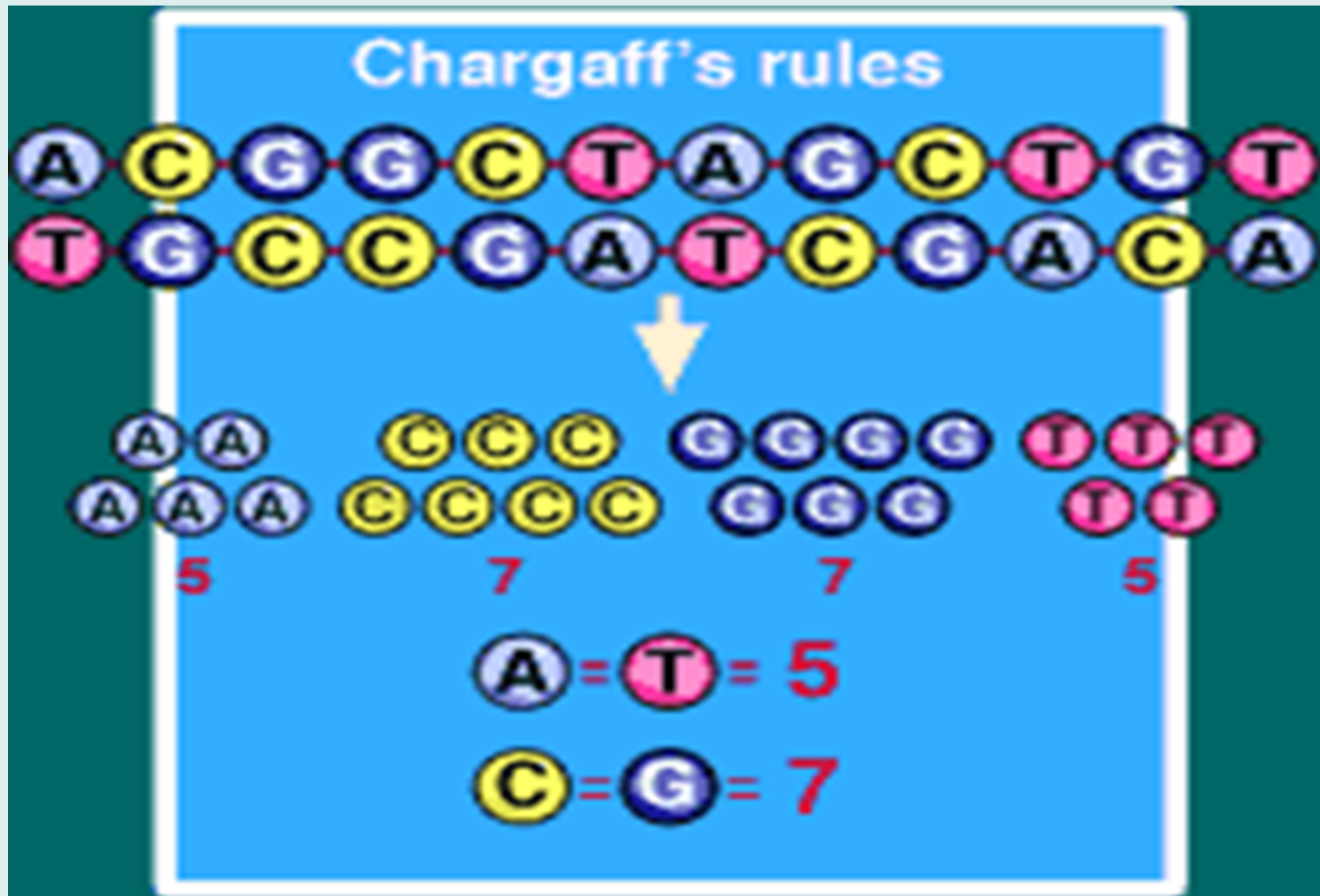
# Chargaff's Rules

- In the 1950s, Edwin Chargaff found that the amount of adenine in DNA always equals the amount of thymine.
- He also found that the amount of guanine always equals the amount of cytosine.





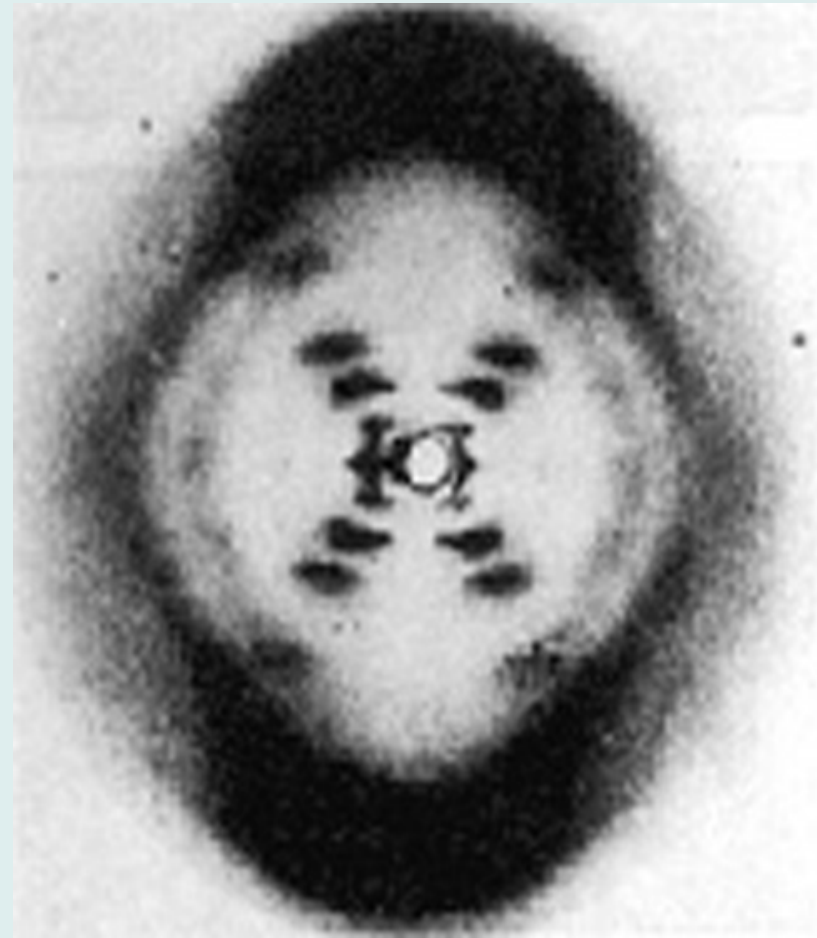
# Chargaff Rules





# *Franklin's discovery*

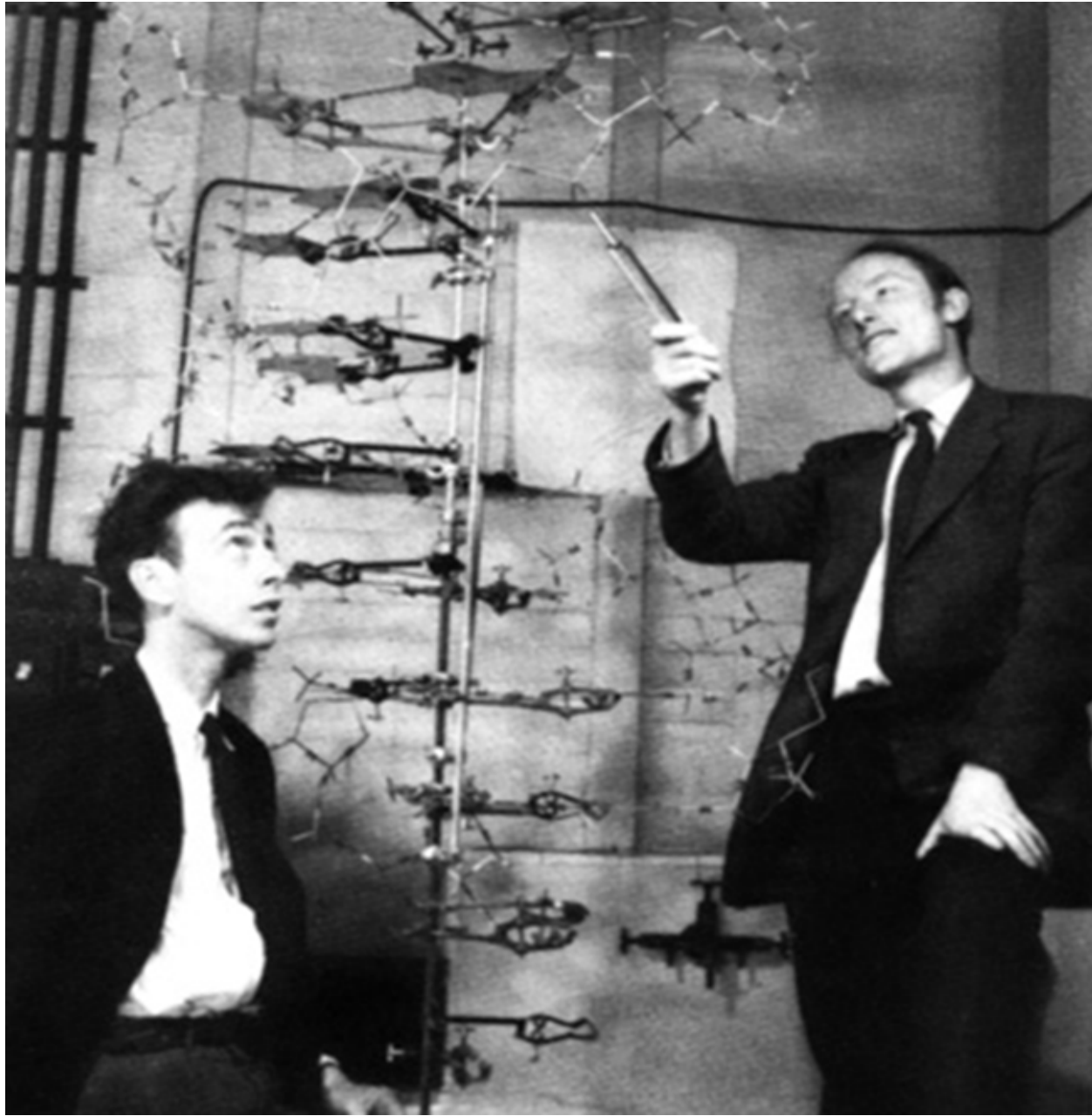
- Rosalind Franklin used a technique called *X-ray diffraction*, where x-rays are aimed at the DNA molecule. When the ray hits DNA it bounces off. The pattern made by the bouncing rays is captured on film.
- Franklin's images suggested that the DNA had a spiral shape.



# *Watson and Crick's Model*

- James Watson and Francis Crick described in 1953 the structure of DNA.
- After seeing Franklin's X-ray images, Watson and Crick concluded that DNA must look like a long, twisted ladder.
- They built a model that perfectly fit with both Chargaff's and Franklin's findings.
- This structure helped explain how DNA is copied and how it functions in the cell.

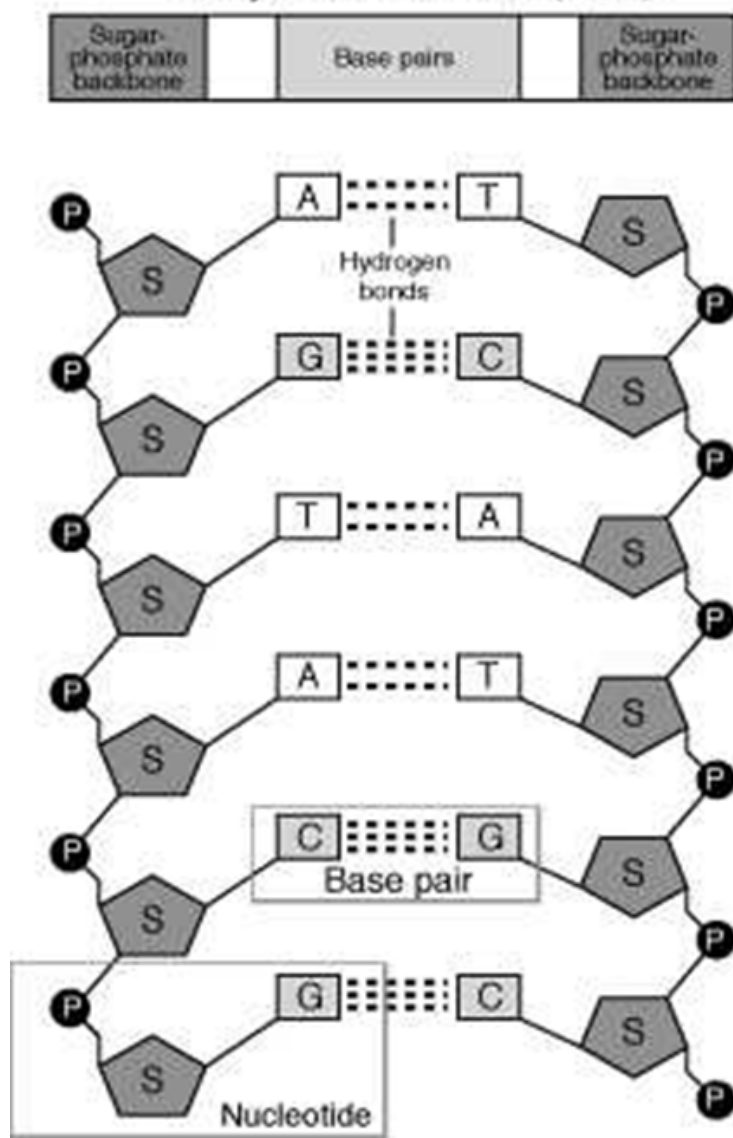




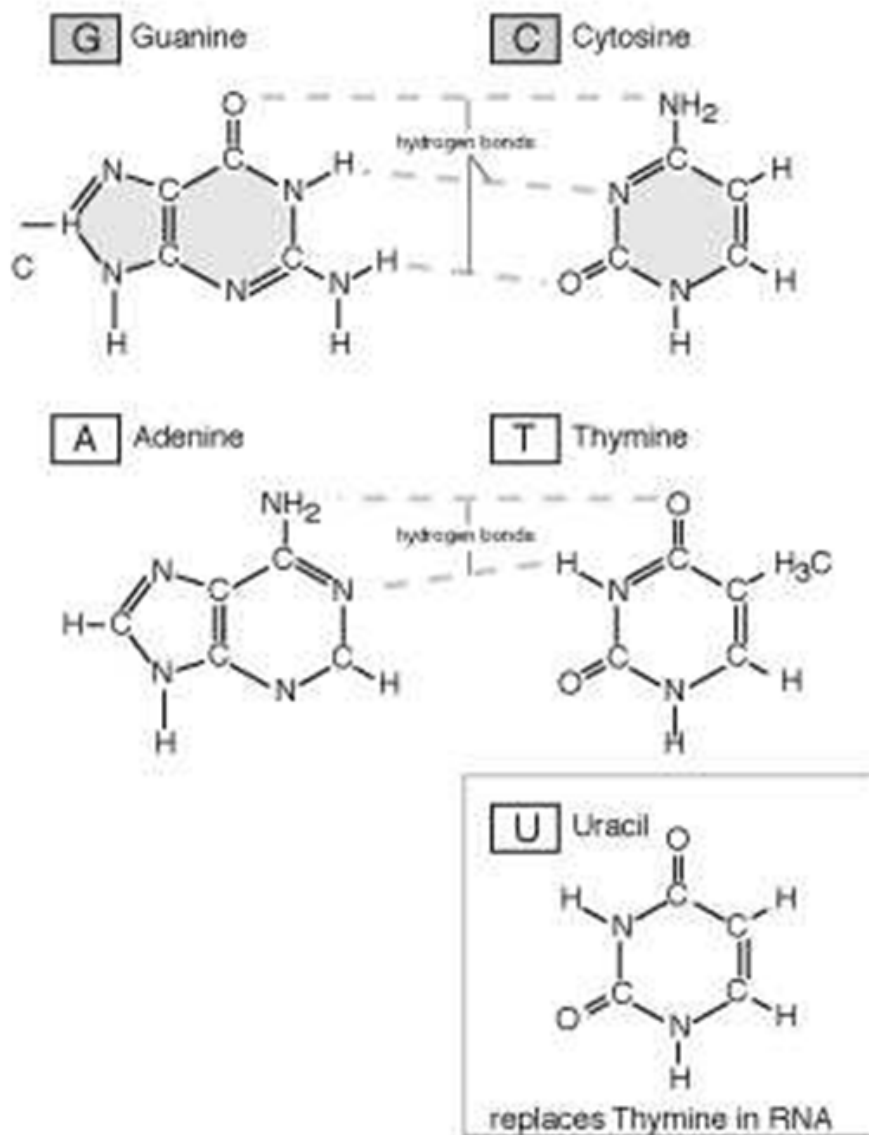
## *DNA's double structure*

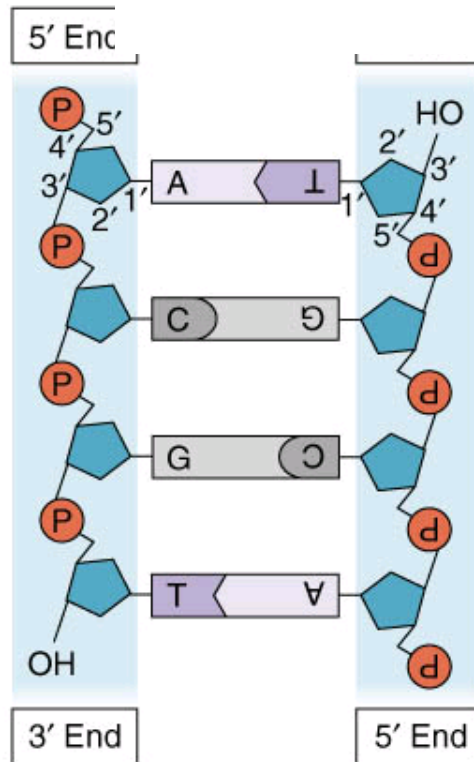
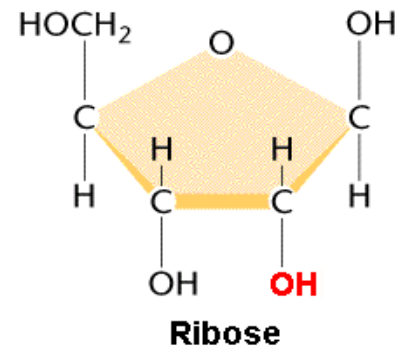
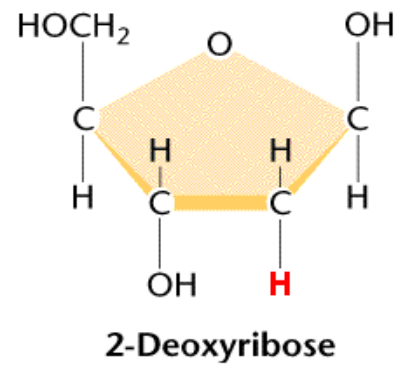
- The twisted ladder shape is known as double helix.
- The two sides of the ladder are made up of alternating sugar and phosphate parts.
- The rungs of the ladder are made up of a pair of bases.
- Adenine always pairs with thymine and cytosine always pairs with guanine. This is in compliance with Chargaff's rules.

## Deoxyribonucleic Acid (DNA)

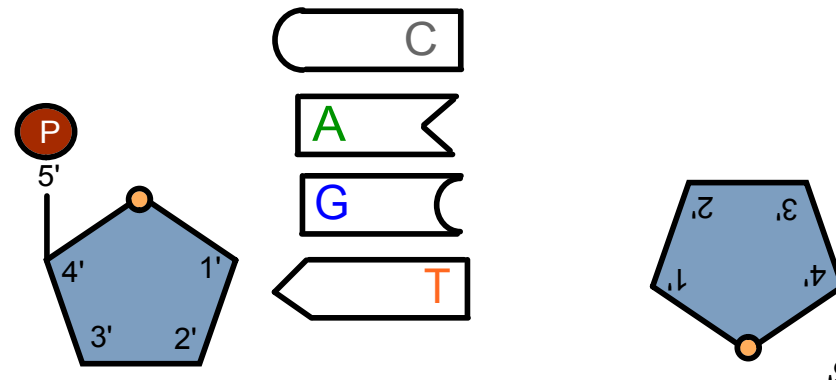


## Nitrogenous Bases





(Klug & Cummings 1997)



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# *DNA Structure*



DNA Structure

<http://goo.gl/Lmaod>



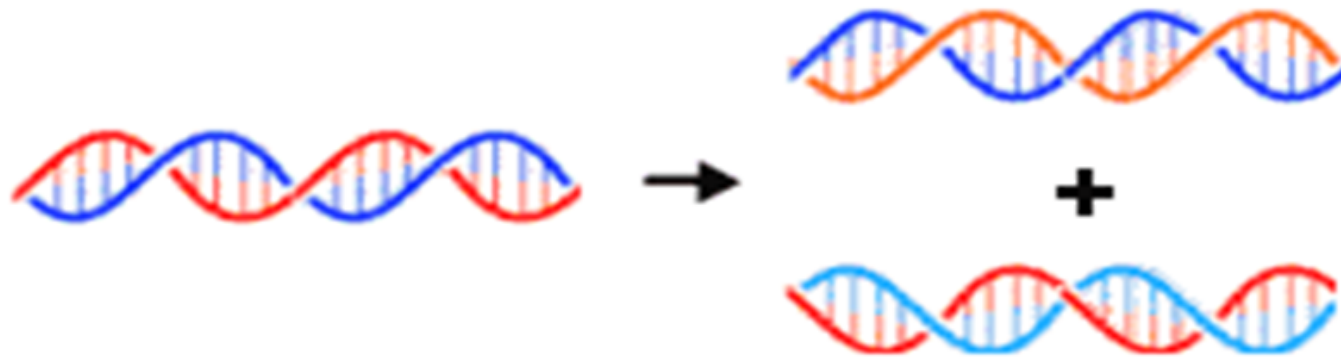
The Central "Dogma" of Biochemistry

<http://goo.gl/hFEEJ>

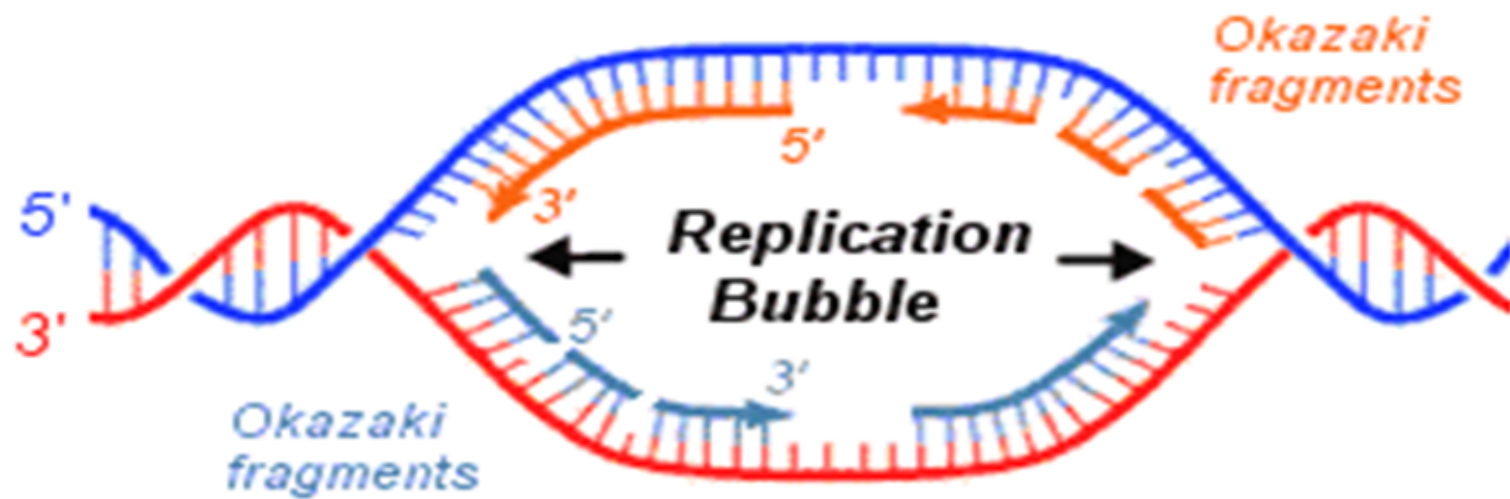


# **DNA Replication**

- During replication, the DNA molecule is split down the middle, where the bases meet.
- The bases on each side of the molecule are used as a pattern for a new strand.
- As the bases on the original molecule are exposed, complementary nucleotides are added to each side of the ladder.
- Two DNA molecules are formed.
- Half of each of the molecules is old DNA, and half is new DNA.



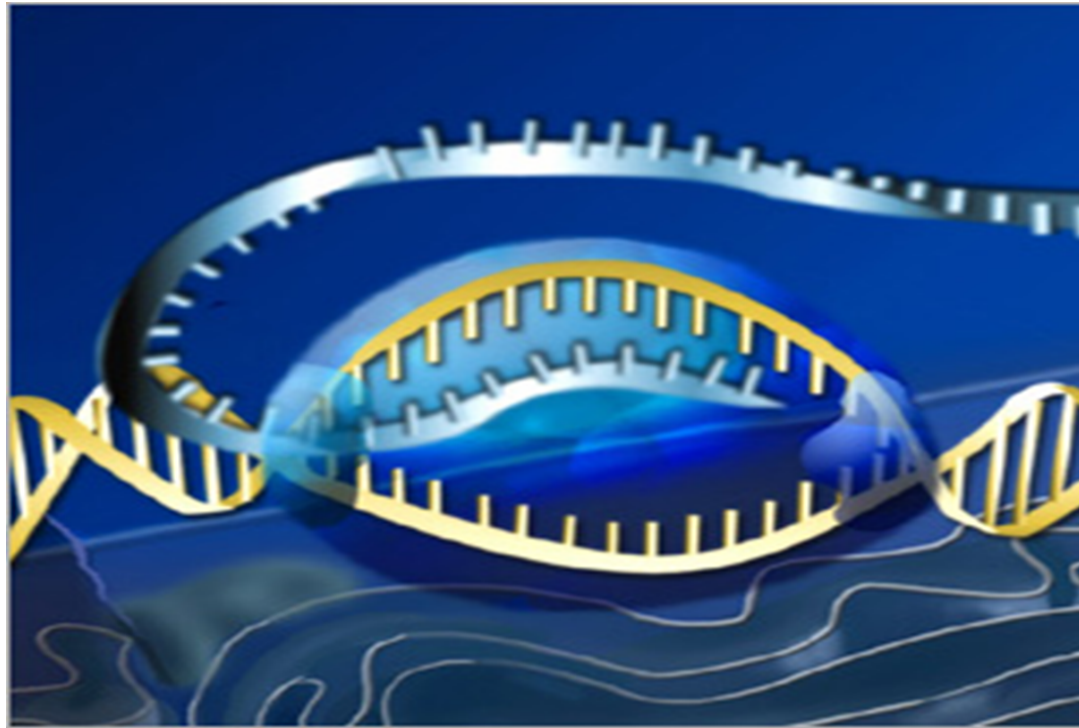
## **Semi-conservative Replication**

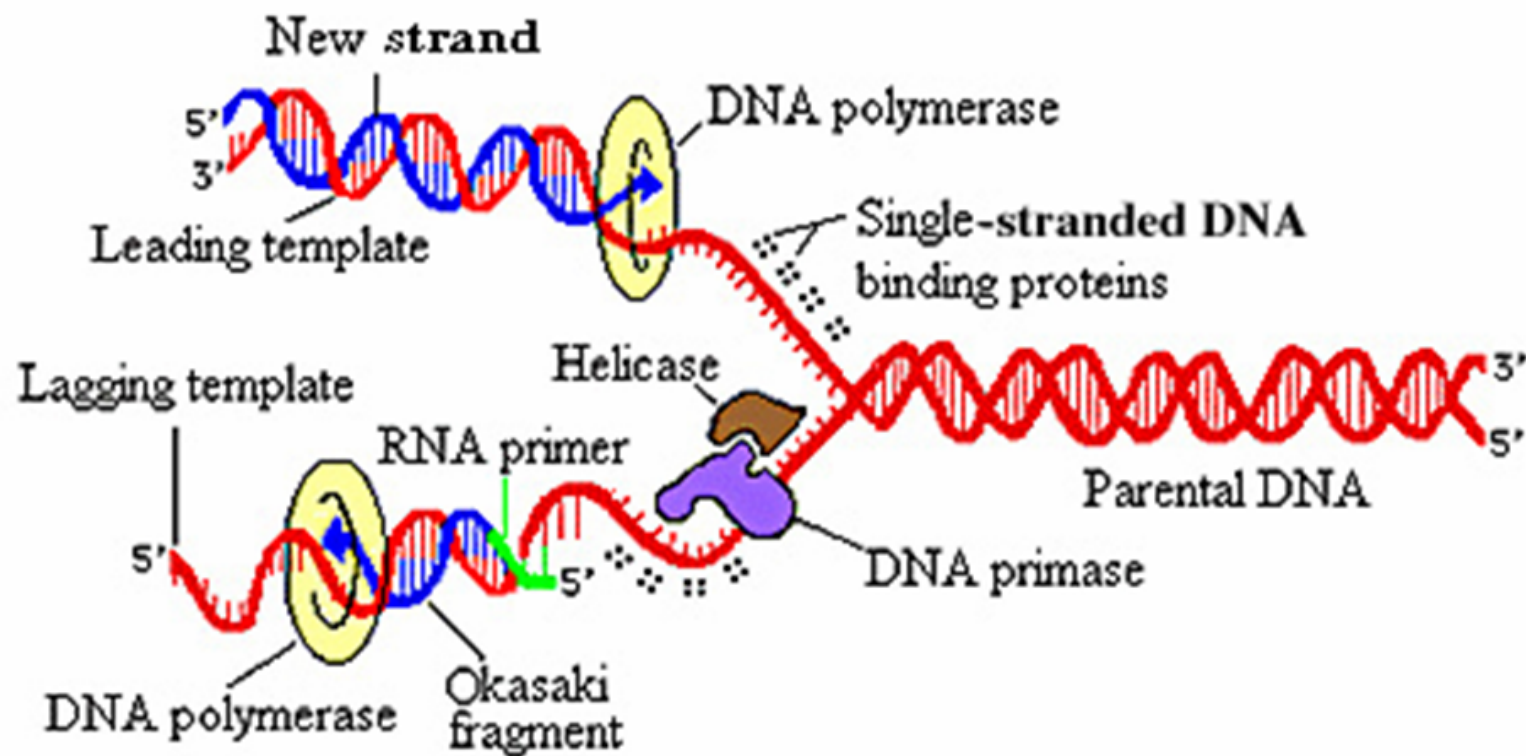


(c) 2000 Chemis

# *DNA Replication*

- DNA is copied every time a cell divides.
- Each new cell gets a complete new copy of all the DNA.
- However, the job of unwinding, copying and re-winding the DNA molecule is done by proteins.





## **Collaboration of Proteins at the Replication Fork**



DNA Replication

<http://bit.ly/98Bzud>



DNA Replication

John Kyrk

<http://bit.ly/dvRxDA>



DNA Replication

<http://goo.gl/hFEEJ>

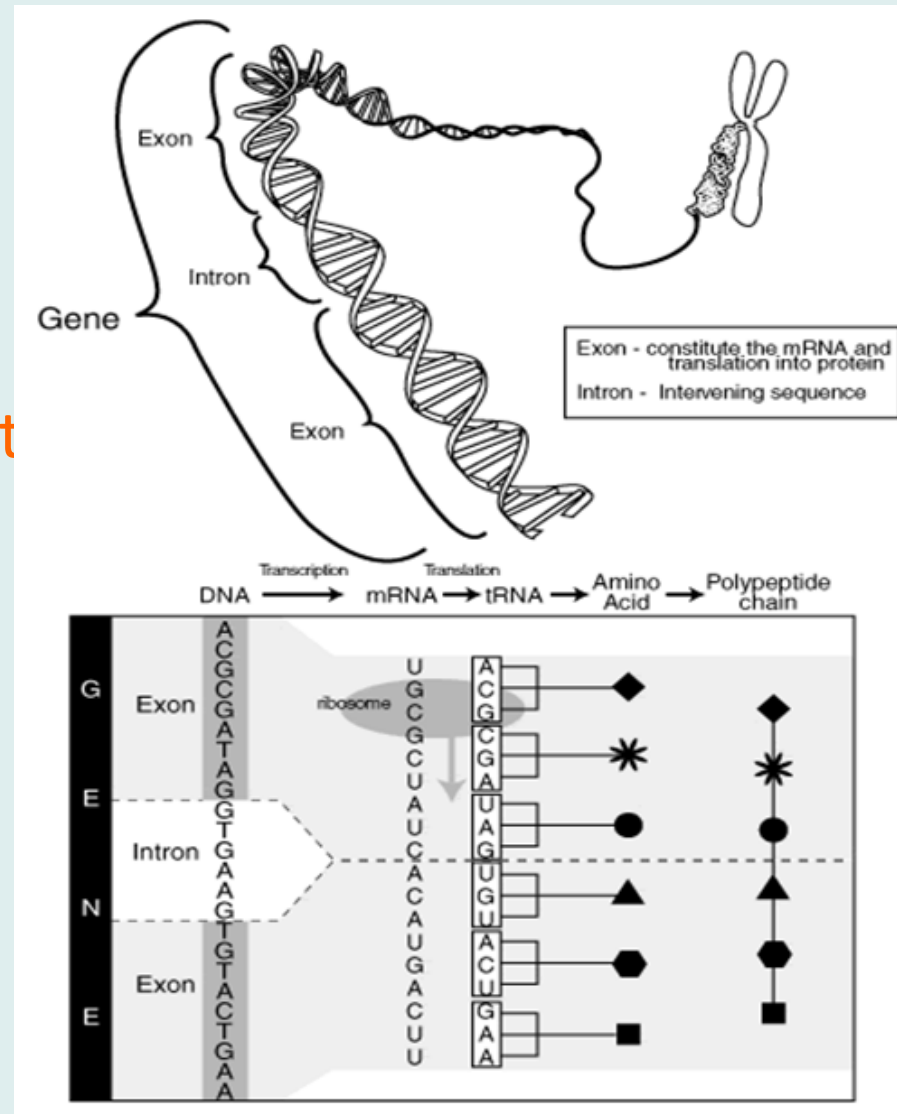
# DNA

- DNA is found in the cells of all living organisms.
- Each organism has a unique set of DNA.
- However, DNA functions the same way in all organisms.
- The structure of DNA allows it to hold information.
- The order of the bases on one side of the molecule is a code that carries information.



# DNA

- A **gene** consists of a string of nucleotides that give the cell information about how to make a specific trait.
- Humans have around 30,000 genes.

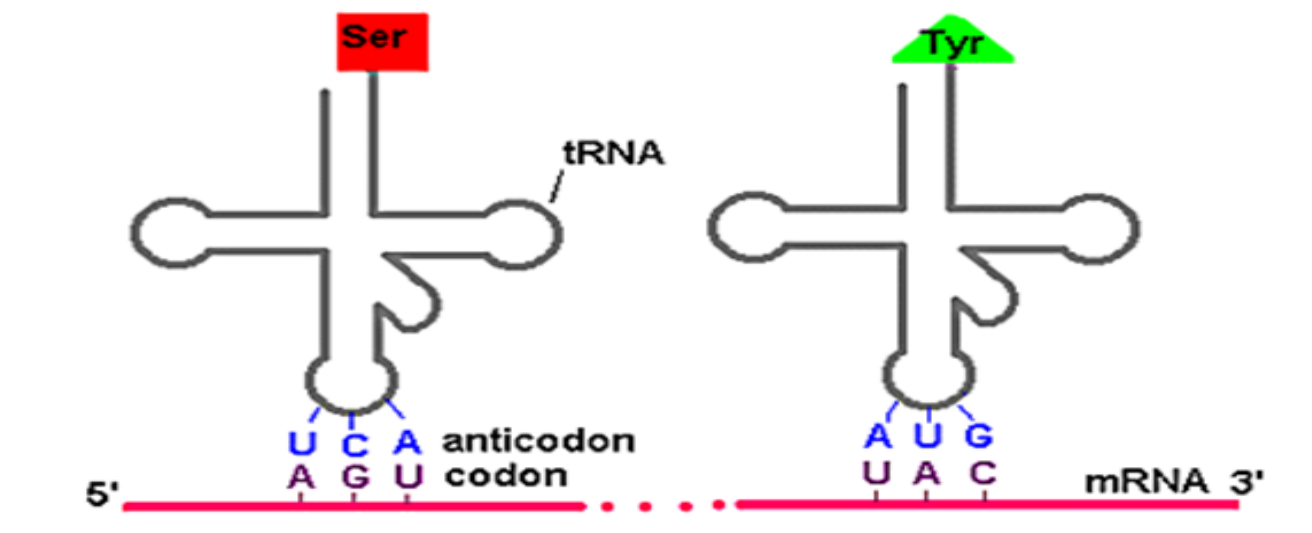


# *Genes and Proteins*

- The DNA code is read like a book, from one end to the other and in one direction.
- The bases form the alphabet of the code (A, T, C, G).
- For the information to be read, the bases form groups of three bases together, these groups are called codons (triplets).
- Every codon is the instruction for a specific amino acid.
- A long string of amino acids forms a protein.
- Thus, each gene is usually a set of instruction for making a protein.

## The Genetic Code

	U	C	A	G	
U	<div>UUU Phe</div> <div>UUC ala</div> <div>UUG Leu</div> <div>UUA Leu</div>	<div>UCU Ser</div> <div>UCC Ser</div> <div>UCA Ser</div> <div>UCG Ser</div>	<div>UAU Tyr</div> <div>UAC Tyr</div> <div>UAA Stop</div> <div>UAG Stop</div>	<div>UGU Cys</div> <div>UGC Cys</div> <div>UGA Stop</div> <div>UGG Trp</div>	U C A G
C	<div>CUU Leu</div> <div>CUC Leu</div> <div>CUA Leu</div> <div>CUG Leu</div>	<div>CCU Pro</div> <div>CCC Pro</div> <div>CCA Pro</div> <div>CCG Pro</div>	<div>CAU His</div> <div>CAC His</div> <div>CAA Gln</div> <div>CAG Gln</div>	<div>CGU Arg</div> <div>CGC Arg</div> <div>CGA Arg</div> <div>CGG Arg</div>	U C A G
A	<div>AUU Ile</div> <div>AUC Ile</div> <div>AUA Ile</div> <div>AUG Met</div>	<div>ACU Thr</div> <div>ACC Thr</div> <div>ACA Thr</div> <div>ACG Thr</div>	<div>AAU Asn</div> <div>AAC Asn</div> <div>AAA Lys</div> <div>AAG Lys</div>	<div>AGU Ser</div> <div>AGC Ser</div> <div>AGA Arg</div> <div>AGG Arg</div>	U C A G
G	<div>GUU Val</div> <div>GUC Val</div> <div>GUA Val</div> <div>GUG Val</div>	<div>GCU Ala</div> <div>GCC Ala</div> <div>GCA Ala</div> <div>GCG Ala</div>	<div>GAU Asp</div> <div>GAC Asp</div> <div>GAA Glu</div> <div>GAG Glu</div>	<div>GGU Gly</div> <div>GGC Gly</div> <div>GGA Gly</div> <div>GGG Gly</div>	U C A G

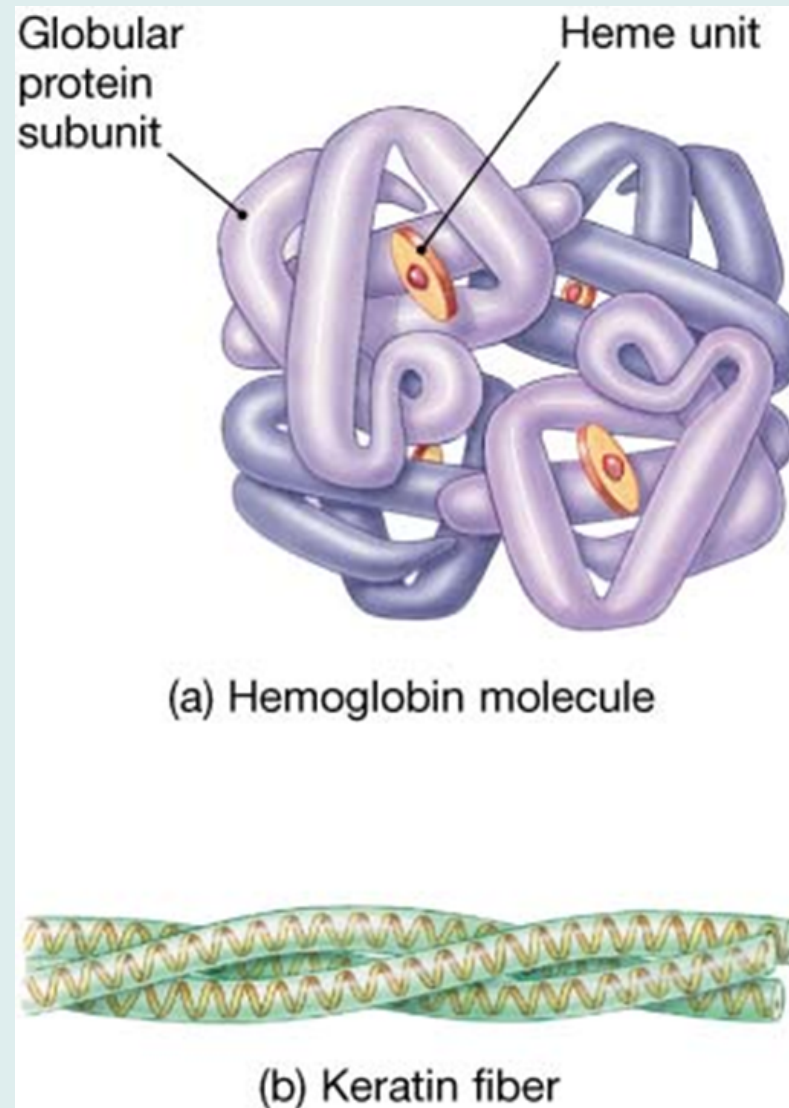


		2nd base in codon					
		U	C	A	G		
1st base in codon	U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr STOP STOP	Cys Cys STOP Trp	U C A G	3rd base in codon
	C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gln Gln	Arg Arg Arg Arg	U C A G	
	A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G	
	G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G	

## The Genetic Code

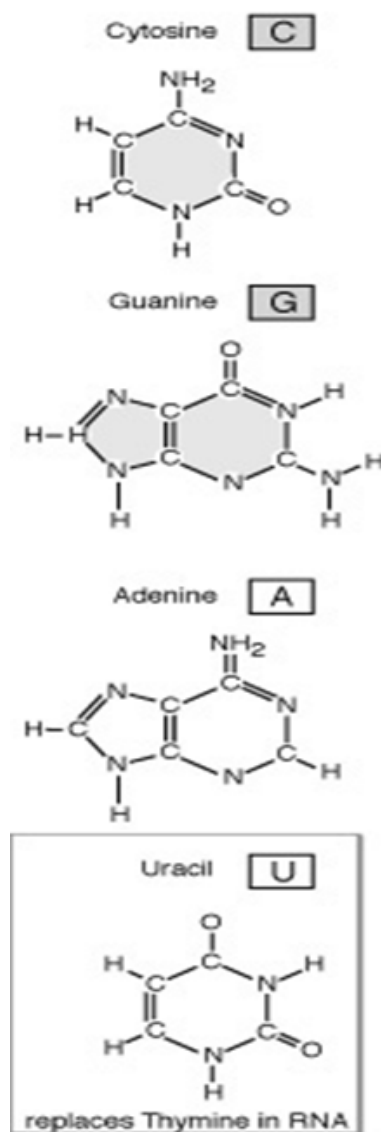
# *Proteins and Traits*

- Proteins are found throughout cells and cause most of the differences that you can see among organisms.
- Proteins exist in an almost limitless variety.

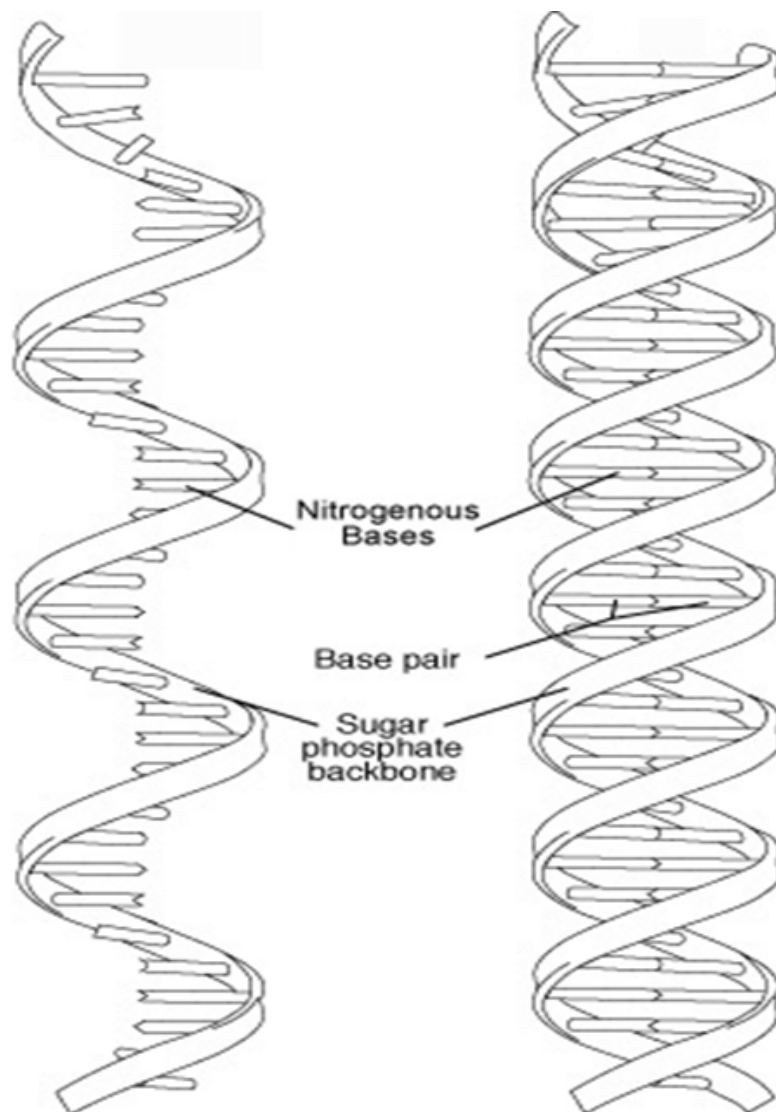


# RNA

- Another type of molecule assisting in the production of proteins is the RNA (Ribonucleic acid).
- RNA is so similar to DNA, that it can serve as a temporary copy of a DNA sequence.
- There are three types of RNA: mRNA (messenger RNA), rRNA (ribosomal RNA) and tRNA (transference RNA).



**Nitrogenous Bases**

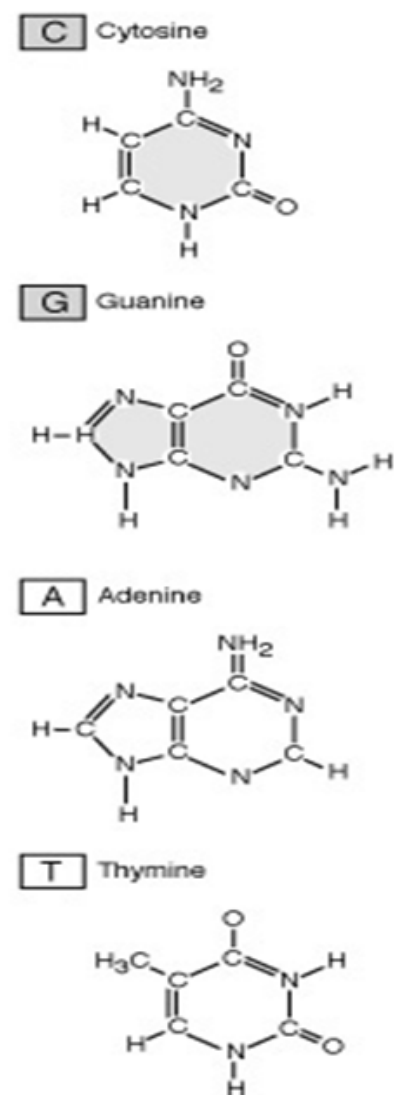


**RNA**

Ribonucleic acid

**DNA**

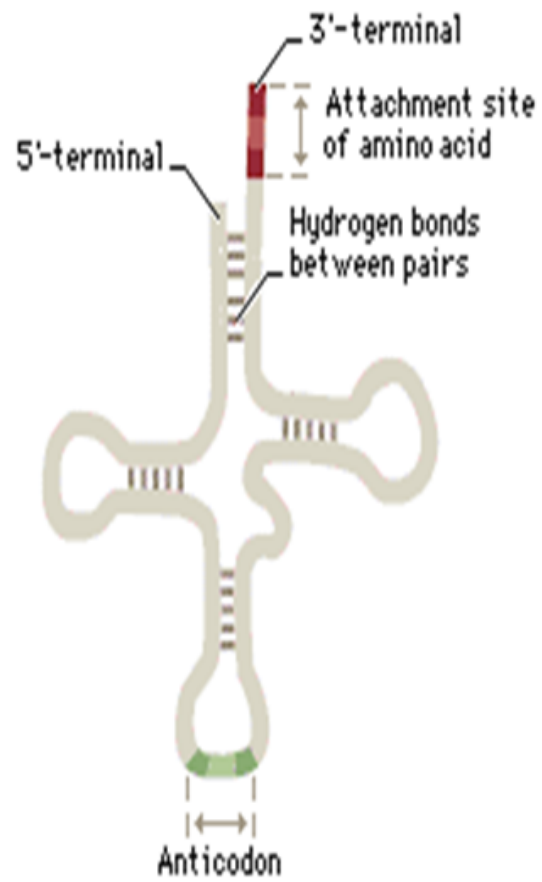
Deoxyribonucleic acid



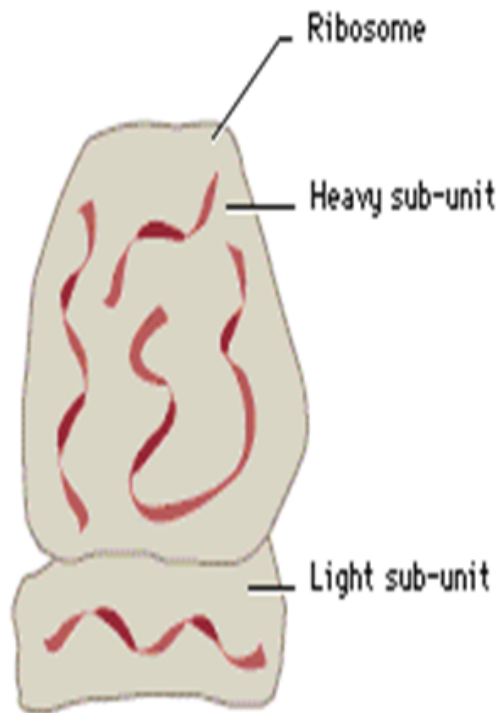
**Nitrogenous Bases**



**Messenger RNA**



**Transfer RNA**



**Ribosomal RNA**





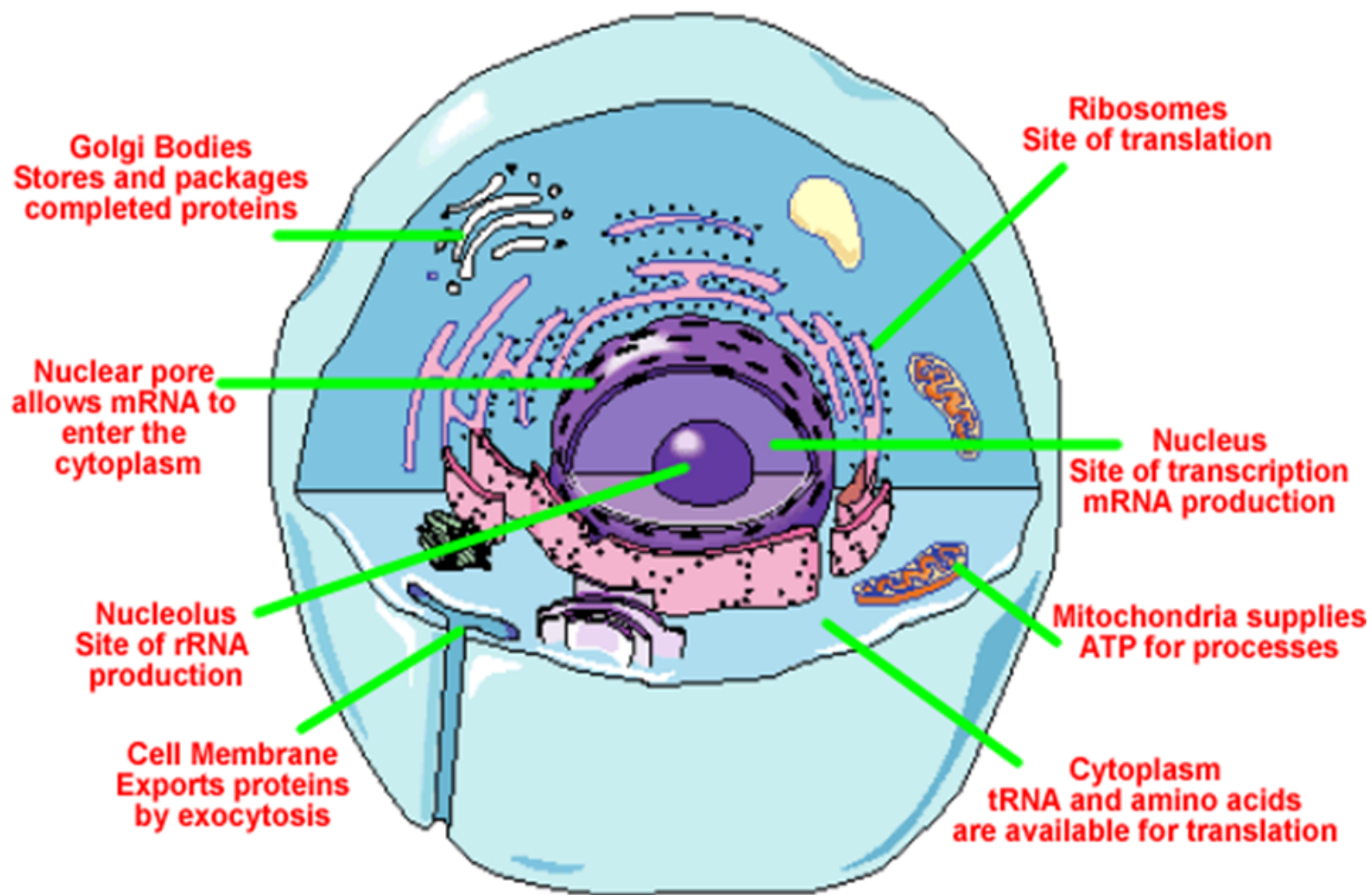
DNA Transcription

<http://goo.gl/IJhCe>

## *The making of a protein*

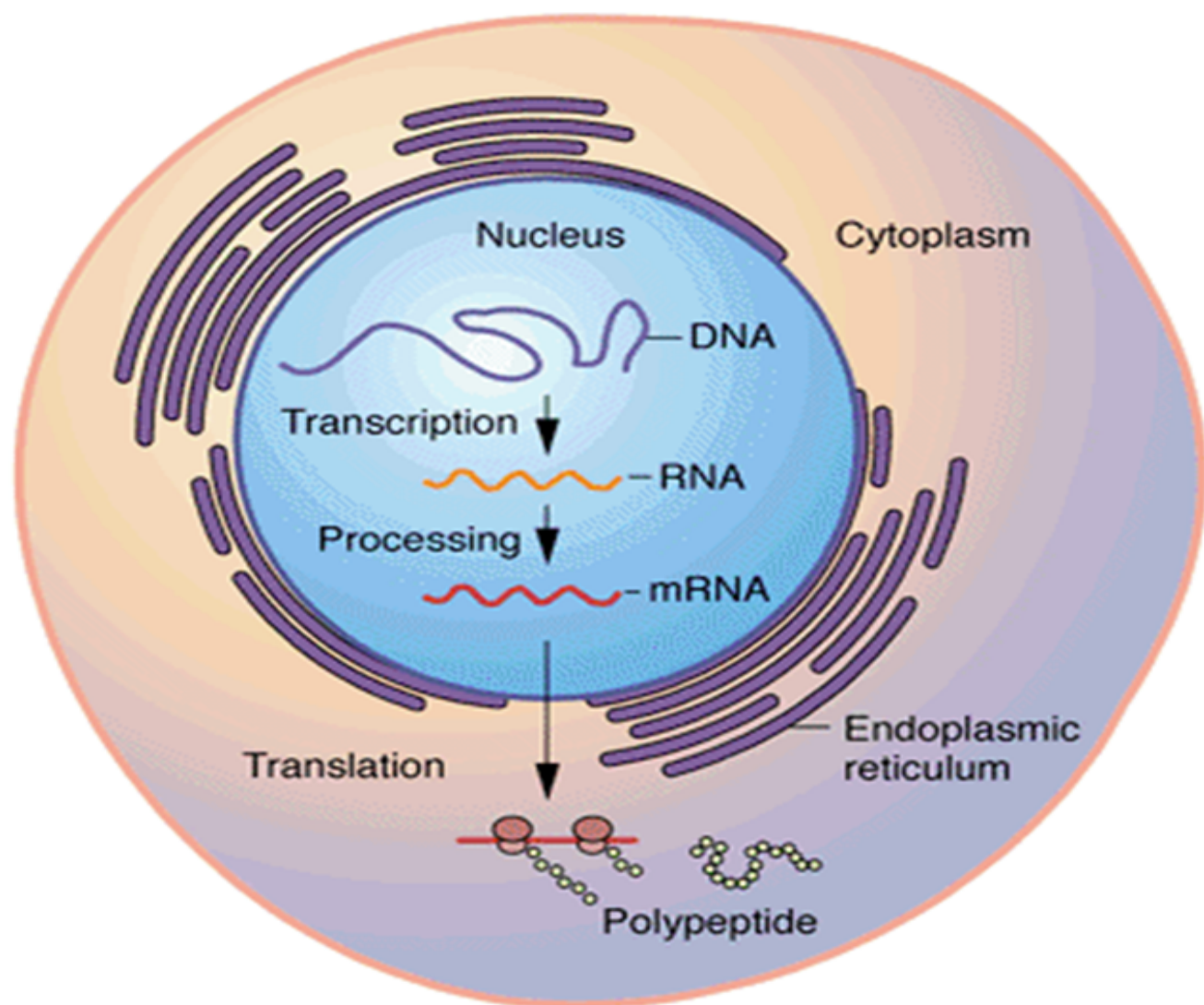
- The first step in making a protein is to copy one side of the segment of DNA containing a gene.
- A mirrorlike copy of the DNA segment is made out of RNA. This copy is called messenger RNA (mRNA), and this process is called Transcription.
- It moves out of the nucleus and into the cytoplasm of the cell.
- In the cytoplasm, the mRNA is fed through a protein assembly line. The “factory” that runs the assembly line is called ribosome.

## *Protein Synthesis - The role of cell organelles*



# *The making of a protein*

- A ribosome is a cell organelle composed of ribosomal RNA (rRNA) and protein.
- The ribosomes and the mRNA participate in the process called translation as follows:
  - The mRNA is fed through the ribosome three bases at a time, codon by codon.
  - Then, molecules of transfer RNA (tRNA) translate the RNA message.
  - Each tRNA picks up a specific amino acid from the cytoplasm.

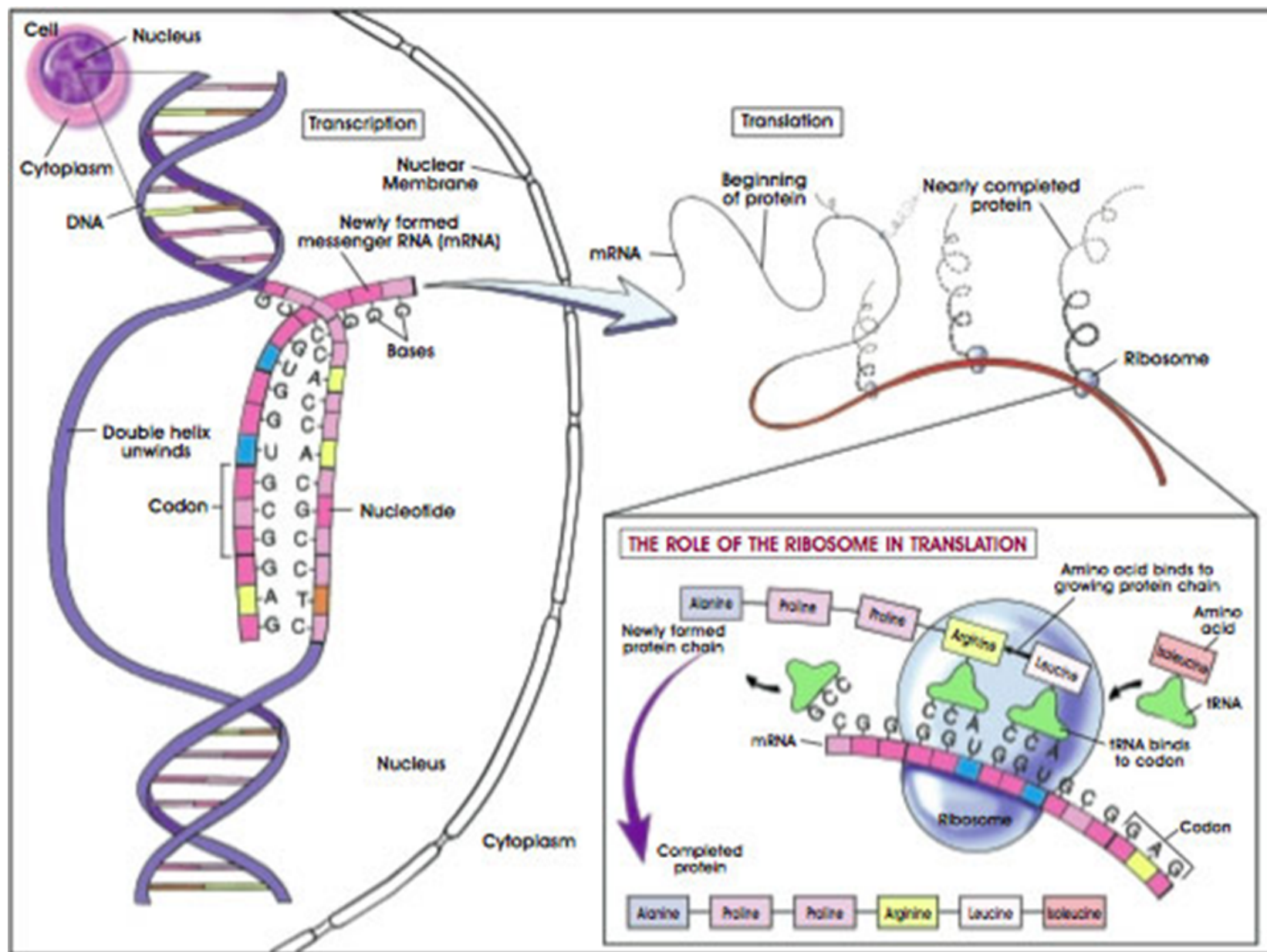


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# *The making of a protein*

- Inside the ribosome, bases on the tRNA match up with bases on the mRNA like pieces of a puzzle.
- The tRNA molecules then release their amino acids.
- The amino acids become linked in a growing chain.
- As the entire mRNA passes through the ribosome, the growing chain of amino acids folds up into a new protein molecule.







Translation in Detail  
<http://bit.ly/d5kLtm>





Translation  
<http://bit.ly/d6lt6t>



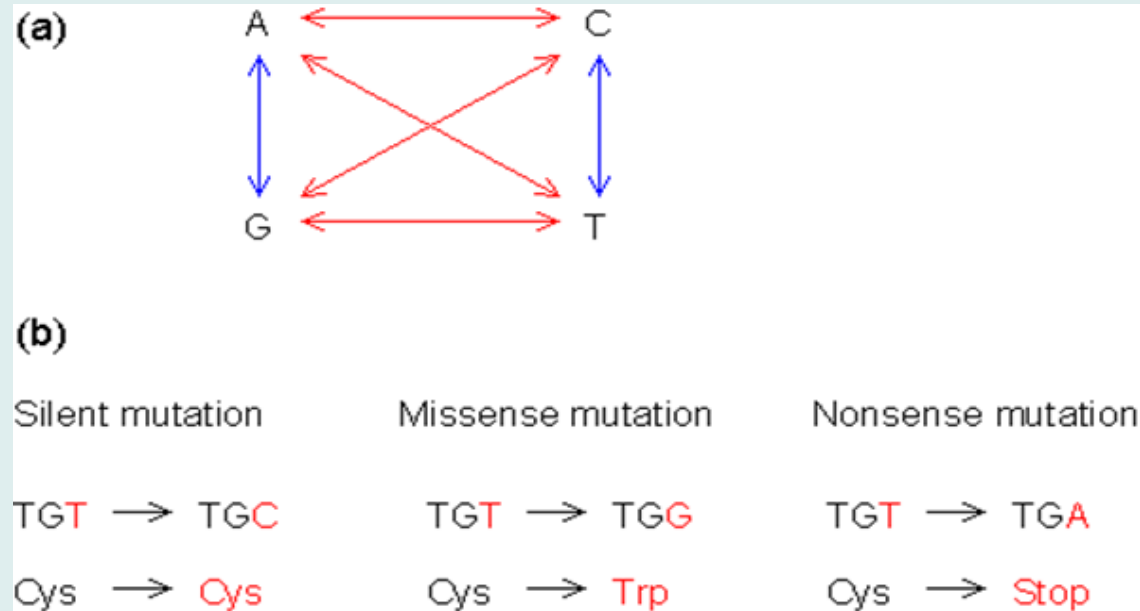
RNA Translation

John Kyrk

<http://bit.ly/dw74Db>

## *Changes in genes: Mutations*

- Accidental substitutions can happen in DNA. Changes in the number, type or order of bases in the DNA are known as mutations.
- Sometimes a base is left out, in those cases it is called a deletion.
- Or, an extra base might be added. This is known as an insertion.
- The most common mistake happens when the wrong base is used. This is known as a substitution.



### deletion mutation

WILD-TYPE  
DNA

ATGCATGCATGC  
TACGTACGTACG

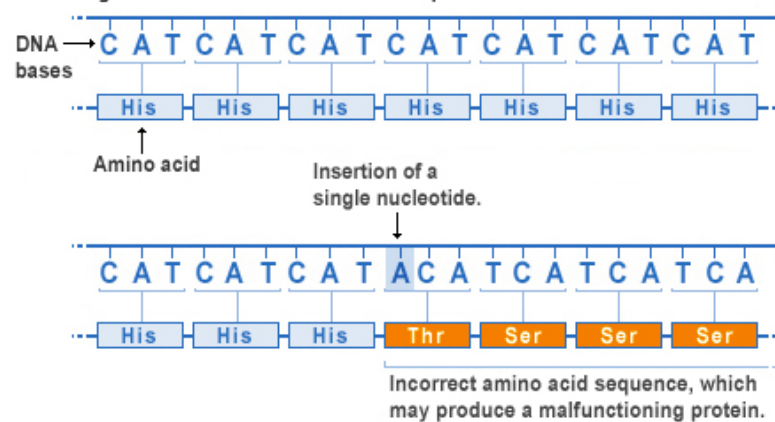
**ATG**  
**TAC** deleted

MUTANT  
DNA

ATGCCATGC  
TACGGTACG

### Insertion mutation

Original DNA code for an amino acid sequence.



U.S. National Library of Medicine

# *Mutations*

- There are three possible consequences of a mutation: an improved trait, no change, or a harmful trait.
- Fortunately, cells make some proteins that can detect errors in DNA. Those errors are usually repaired.
- But sometimes the repairs are not accurate, and the mistakes become part of the genetic message.
- If the mutation occurs in the sex cells, the changed gene can be passed from one generation to the next.

### Original DNA Template Strand

3' TACTGGGTGCTACCCACT 5'  
5' AUGACCCACGAUGGGUGA 3'

Peptide

Met Thr His Asp Gly

### Missense mutation

3' TACAGGGGTGCTACCCACT 5'  
5' AUGUCCACGAUGGGUGA 3'

Peptide

Met Ser His Asp Gly

### Frameshift mutation

3' TACGGGGTGCTACCCACT 5'  
5' AUGCCCCACGAUGGGUGA 3'

Peptide

Met Pro Thr Met Gly ? ?

# *Mutations*

- Mutations happen regularly because of random errors when DNA is copied.
- In addition, damage to DNA can be caused by abnormal things that happen to cells.
- Any chemical or physical agent that can cause a mutation in DNA is called a mutagen. For example: UV rays, X-rays, high-energy radiation, asbestos, etc.

Before



After





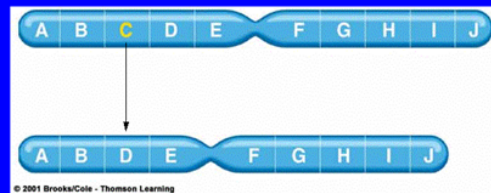
## Substitution:

### *The most common form of mutation*

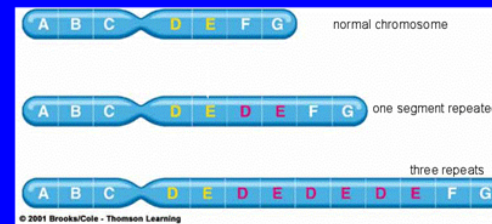
- A substitution can be harmful because it may cause a gene to produce the wrong protein.

#### Deletion

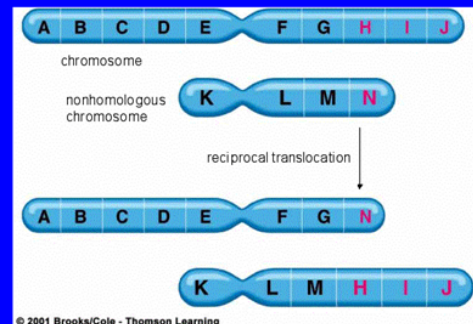
- Loss of some segment of a chromosome
- Most are lethal or cause serious disorder



#### Duplication

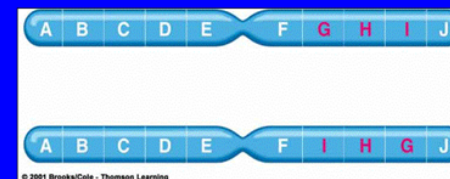


#### Translocation



#### Inversion

A linear stretch of DNA is reversed within the chromosome



## *Sickle Cell Anemia*

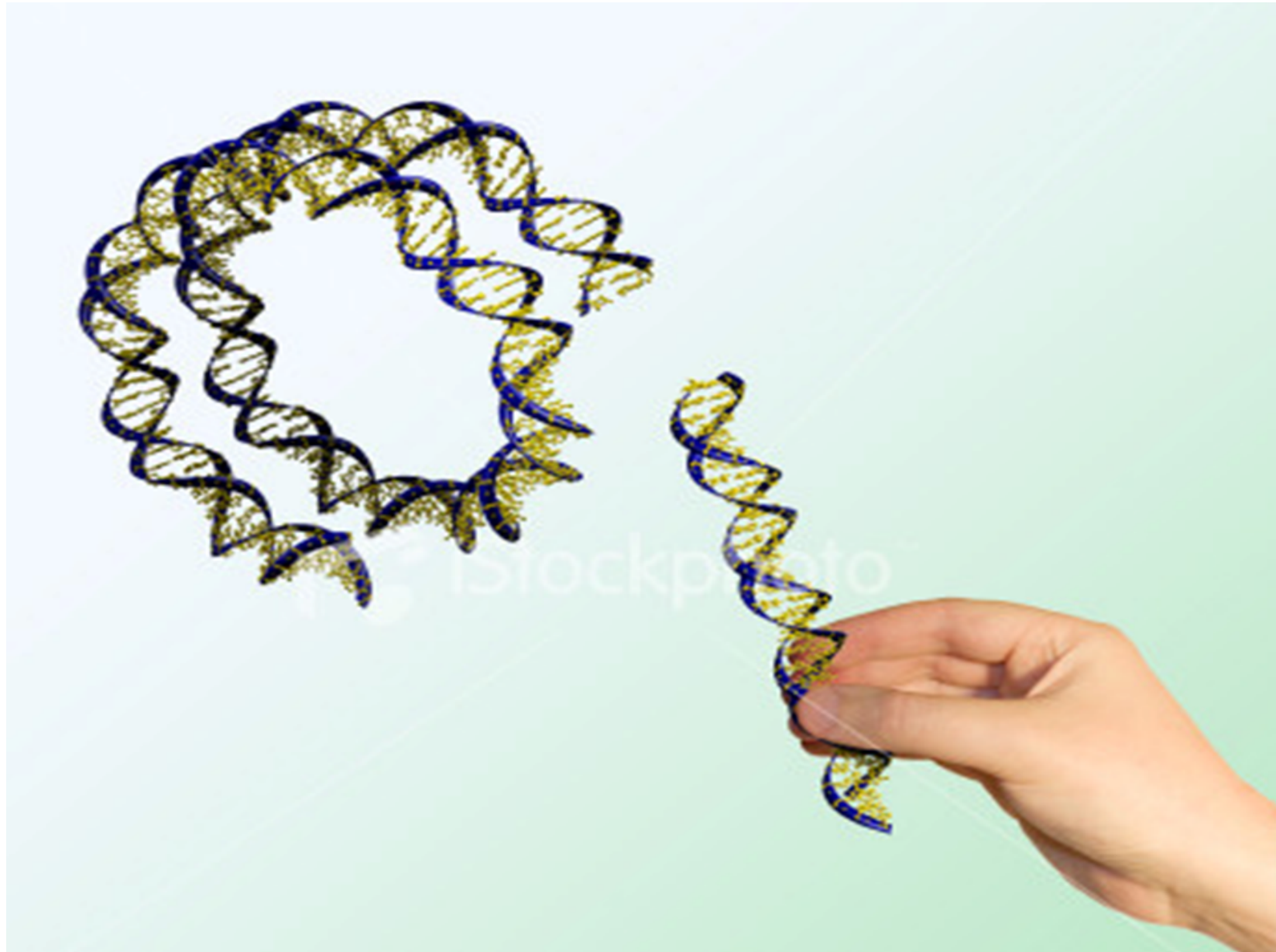
- From the normal mRNA sequence, a codon (GAA) that translates into the amino acid Glutamic acid, the substitution of one base causes the codon to become GTA, and that codon translates into the amino acid Valine.
- This simple change in one base, and one amino acid, provokes the disease.



# *Genetic Knowledge*

## Genetic Engineering (GE)

- GE is the manipulation of individual genes within organisms. In some cases, genes may be transferred from one type of organism to another.
- Scientists may use GE to create new products, such as drugs, foods, or fabrics.

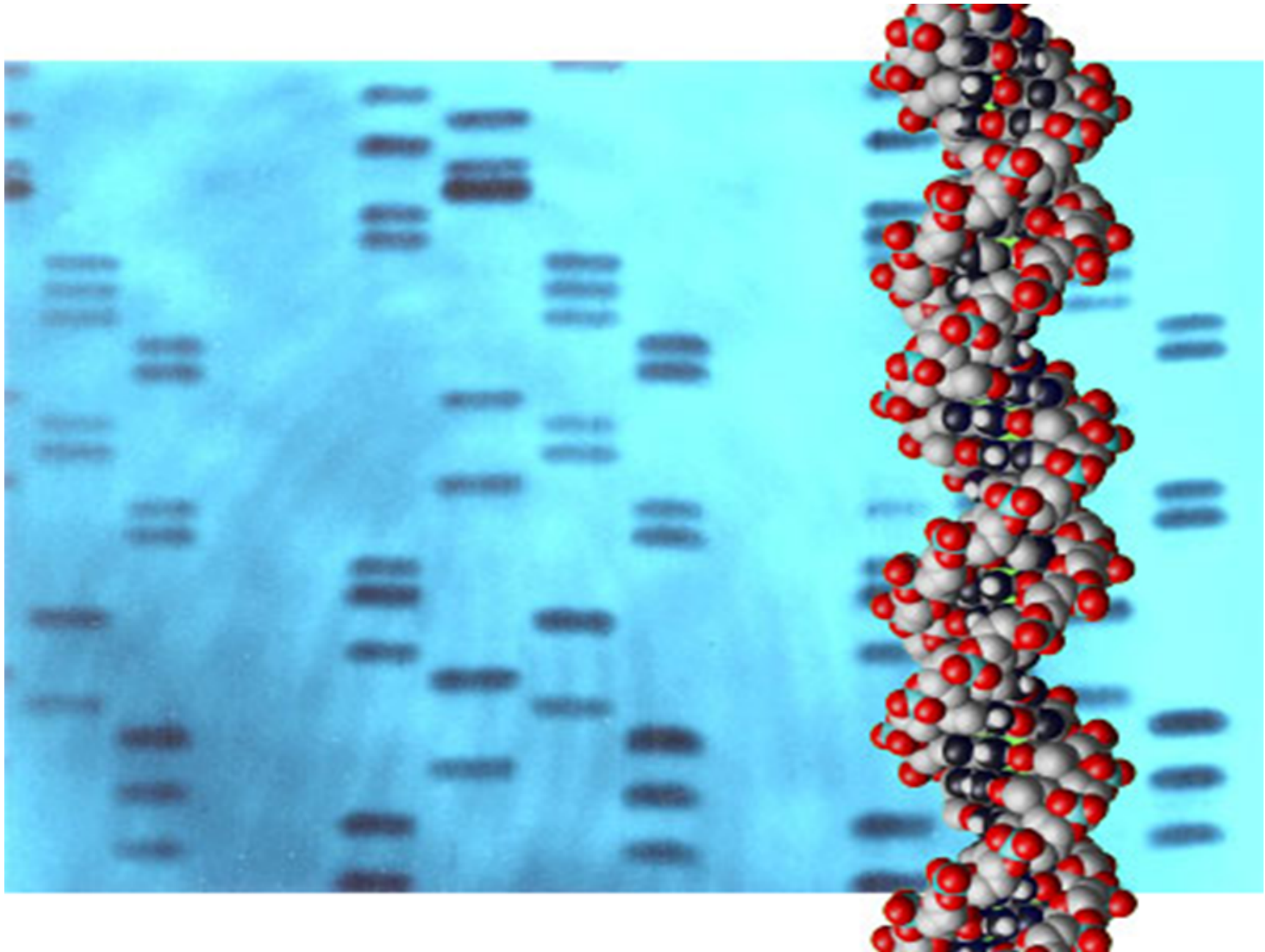


# *Genetic Knowledge*

## Genetic Identification

- Your DNA is unique, so it can be used like a fingerprint to identify you.
- *DNA fingerprinting* identifies the unique patterns in an individual's DNA. In crime cases for example.
- Similarities between people's DNA can reveal other information. DNA can be used to identify family relations on hereditary diseases.





# Protein Production

- Proteins are integral and essential molecules produced by the cell to ensure its structure, functioning and regulation of processes.
- Proteins are produced following the instructions contained in the genetic code (DNA), through the processes of: Transcription and Translation.



Do you remember the Central Dogma of Biology?



DNA Transcription  
Virtual Cell

<http://goo.gl/e2LS8>





RNA Translation  
Virtual Cell

<http://goo.gl/Zr9B7>

# Directing Cellular Activity

- DNA instructions are copied as RNA messages, which leave the nucleus. In the cytoplasm, ribosomes use the RNA messages to assemble proteins.
- mRNA leaves the nucleus through the *nuclear pores*.
- The nucleus also participates in protein production in another central way.
- In the nucleus, the NUCLEOLUS, is the region where rRNA is produced. This rRNA combined with proteins, form the RIBOSOMES.

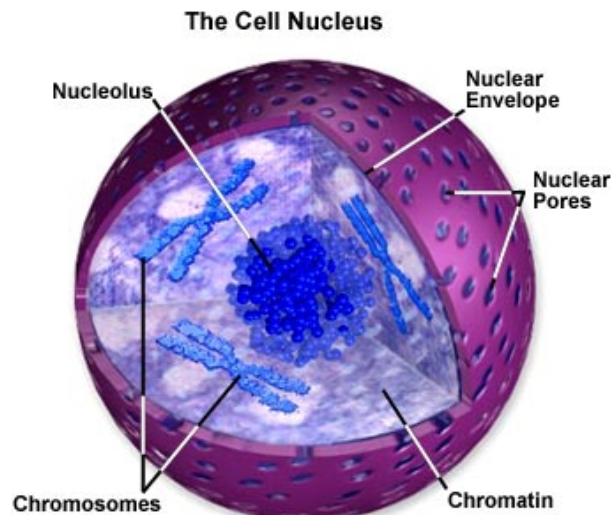


Figure 1

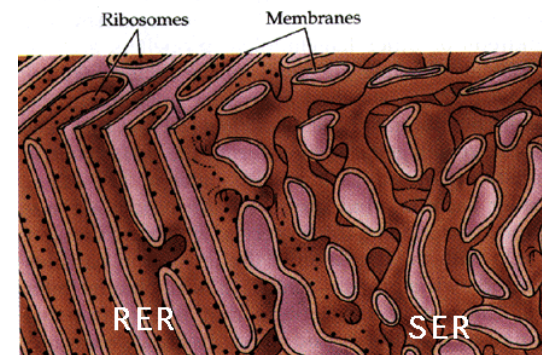
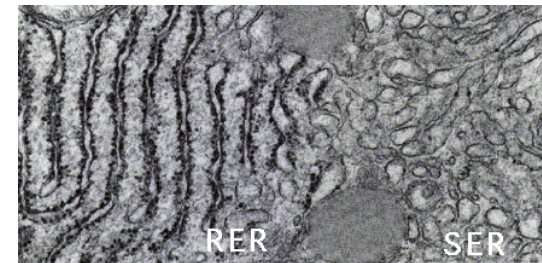
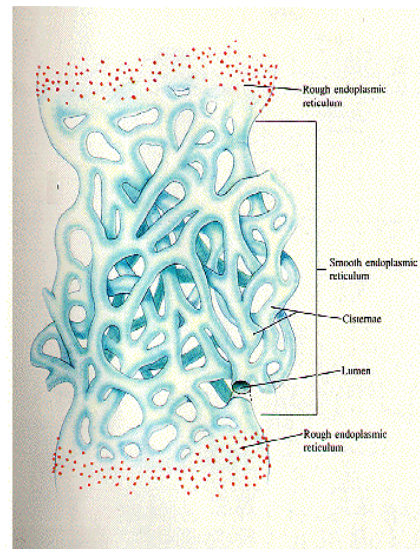
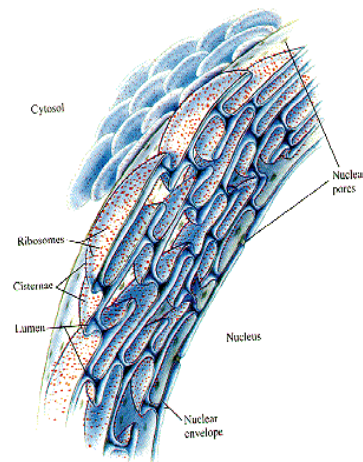
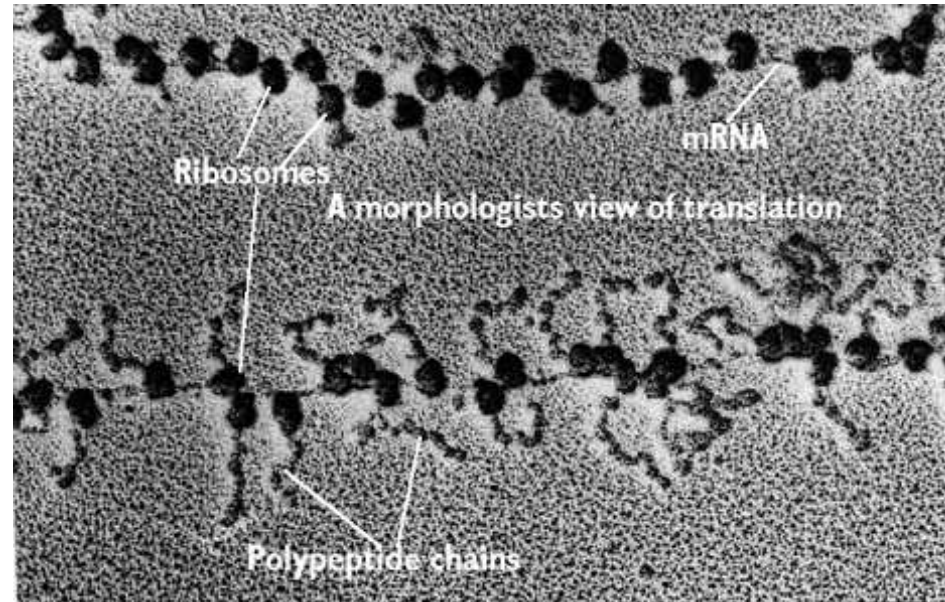
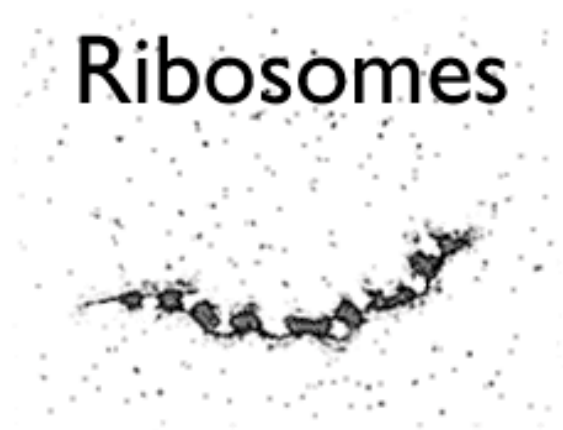
# **RIBOSOMES**

- Each ribosome is made of RNA and many proteins.
- Some ribosomes in eukaryotic cells are suspended in the cytosol, as they are in prokaryotic cells.
- These "free" ribosomes make proteins that remain inside the cell, such as proteins that build new organelles or enzymes to speed chemical reactions.
- Other ribosomes are attached to the membrane of another organelle. These "bound" ribosomes make proteins that must be kept separate from the rest of the cytoplasm.
- Ribosomes can switch between being bound or free depending on the kind of protein that the cell needs to make.

**Cell 3D Animation - Link**

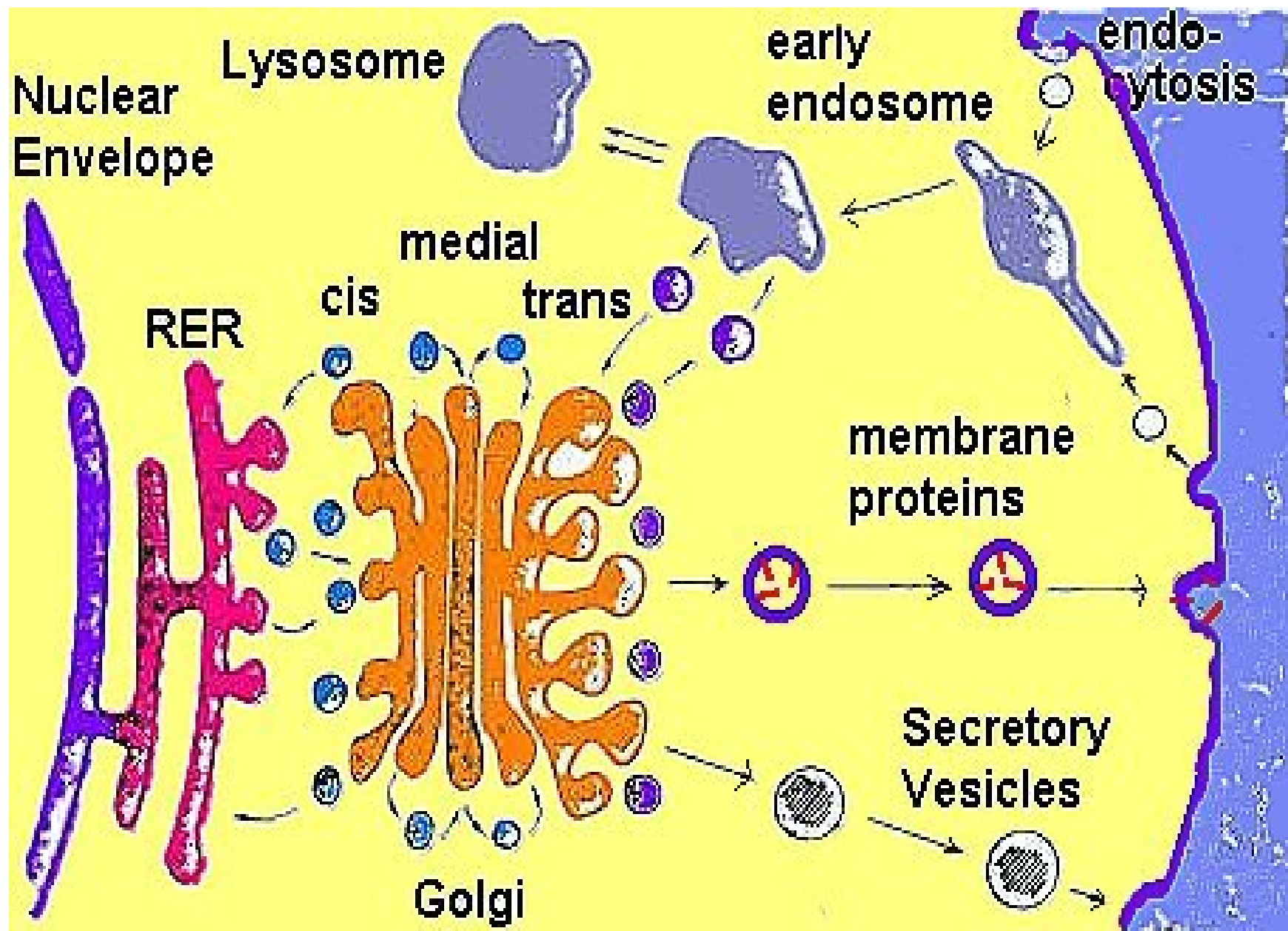
**<http://goo.gl/V68gg>**

# Ribosomes



# Processing Proteins

- The proteins produced by the cells have many uses. Those that are sent outside of the cell must be kept separate from the rest of the cytoplasm.
- This separation is possible because the cell packages the proteins in vesicles.
- A *vesicle* is a small, often spherical-shaped sac that is formed by a membrane.
- In a eukaryotic cell, two structures are mainly responsible for modifying, packaging, and transporting proteins for use outside the cell: the *Endoplasmic Reticulum* and the *Golgi apparatus* are organelles that prepare proteins for extracellular transport.





# Endoplasmic Reticulum

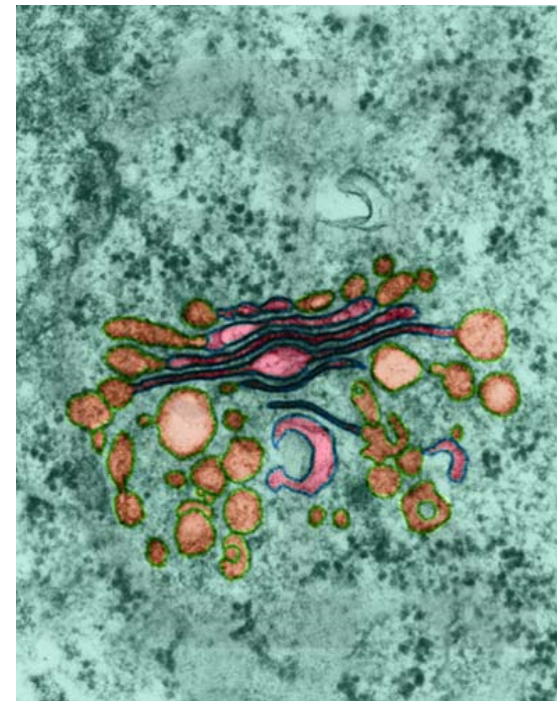
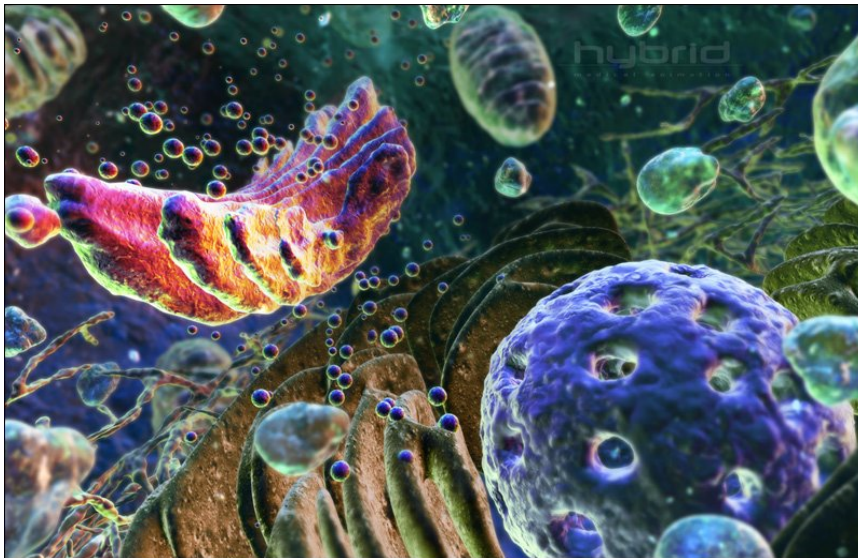
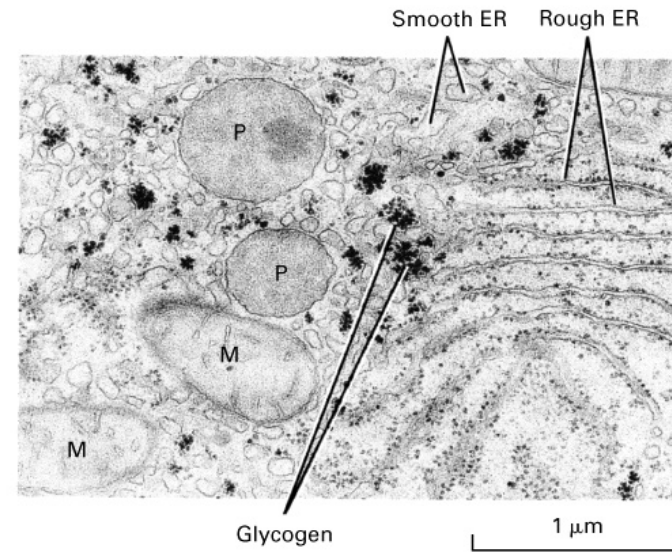
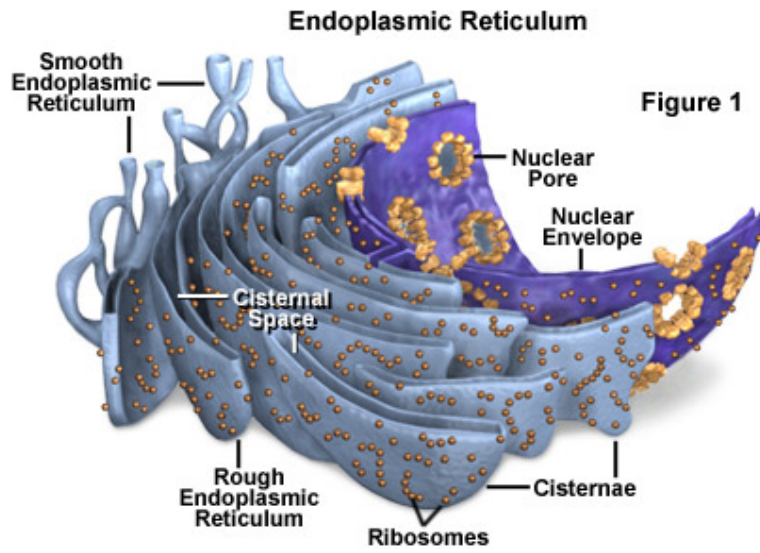
- The ER is a system of internal membranes that moves proteins and other substances through the cell. The membrane of the ER is connected to the outer membrane of the nuclear envelope.

## **ROUGH ER**

- Ribosomes are attached to some parts of the surface of the ER, this Rough ER has a bumpy appearance.
- As proteins are made, they cross the ER membrane, entering the ER.
- Then, the ER pinches off to form a vesicle around the proteins.

## **SMOOTH ER**

- The rest of the ER, is called Smooth ER, because has no attached ribosomes, so it appears smooth under the microscope.
- Enzymes of the Smooth ER perform various functions, such as making lipids and breaking down toxic substances.







Fluid Mosaic Model  
<http://bit.ly/aNvFgK>



Endocytosis and Exocytosis

<http://bit.ly/aioHFU>



Endocytosis and Exocytosis

<http://bit.ly/d4eAuq>



Lysosomes

<http://bit.ly/9gqP6v>

# CELL DYNAMICS

How is the cell organized?

What is happening inside the cell?

How do things move around the cell?

How are processes accomplished in and out of the cell?

What is the one single substance that regulates everything in the cell?



The Inner Life of a Cell

<http://goo.gl/Zi23>

# Cell Metabolism

- Different substances accomplish different functions inside and outside of the cell.
- The four biomolecules are strongly interconnected, due to its participation in the major processes of a cell, and therefore of an organism.
- This interconnection is reflected in the intricate processes of metabolism.
- Metabolism is possible due to the availability of **ENERGY**.
- This is the main drive for chemical reactions to happen, and it is one of the most important processes that cells carry out.
- The production of energy is achieved by: **GLYCOLYSIS**, and **AEROBIC RESPIRATION**.



Vesicle Animation  
Clathrin formation

<http://goo.gl/Gxce5>



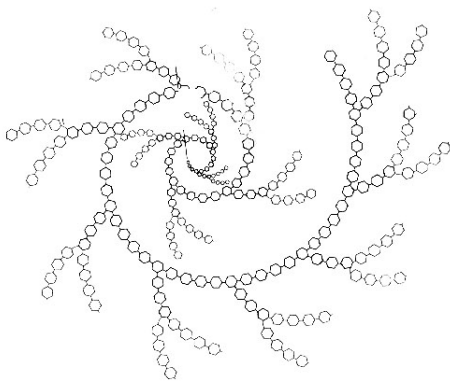
# Intracellular Storage

- Cells use and store substances depending on their biochemical needs.
- What do you think are the major substances stored in the

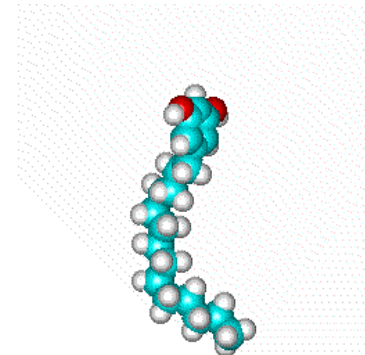
**PROTEINS**



**CARBOHYDRATES**



**LIPIDS**



**The question is, how and where does the cell store these substances?**

# Cell Storage

- The most common substances stored in the intracellular space of animal cells are: CARBOHYDRATES and FATS.

- These are usually stored in vacuoles and inclusions.

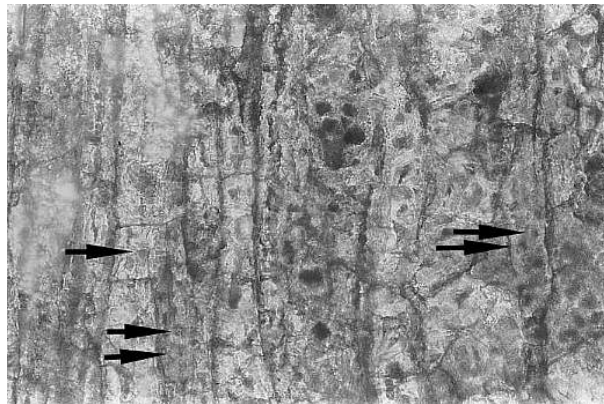
Subcellular inclusions are nonmoving material that are usually the result of metabolic activity of the cells in which they're found.

- In most cases they require special stains to be seen clearly. They may be pigments produced in the cell, or they may be accumulations of nutritive materials such as fat or carbohydrates.

- Animal Cells store Fat, in the form of lipids or cholesterol (in the cell membrane too) in droplets and vacuoles.

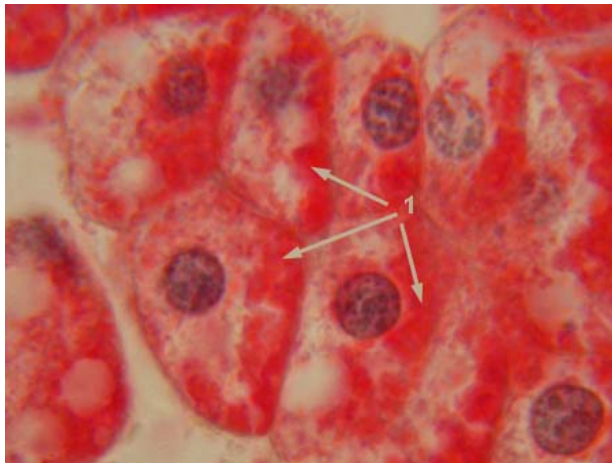
- Plant cells accumulate the extra production of carbohydrates from photosynthesis in vacuoles.

- Plants also store proteins in embryo and vegetative cells to provide carbon, nitrogen and sulfur for subsequent growth and development.

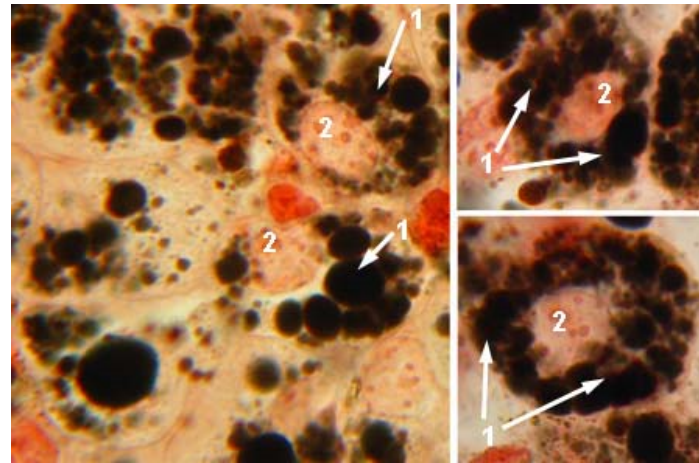


# Storage in Tissues

- Most of the material stored inside the cells, can also be stored in tissues in a large scale.
- This is the case of carbohydrates, that can be stored in animals in: **LIVER**, and **MUSCLE**.
- In the case of fats, the body prefers to fill cells from the adipose tissue with large lipid droplets.
- It is clear that storage of substances in tissues requires the extra production (in plants), or extra intake (in animals) of the precursor molecules: glucose, proteins and lipids.

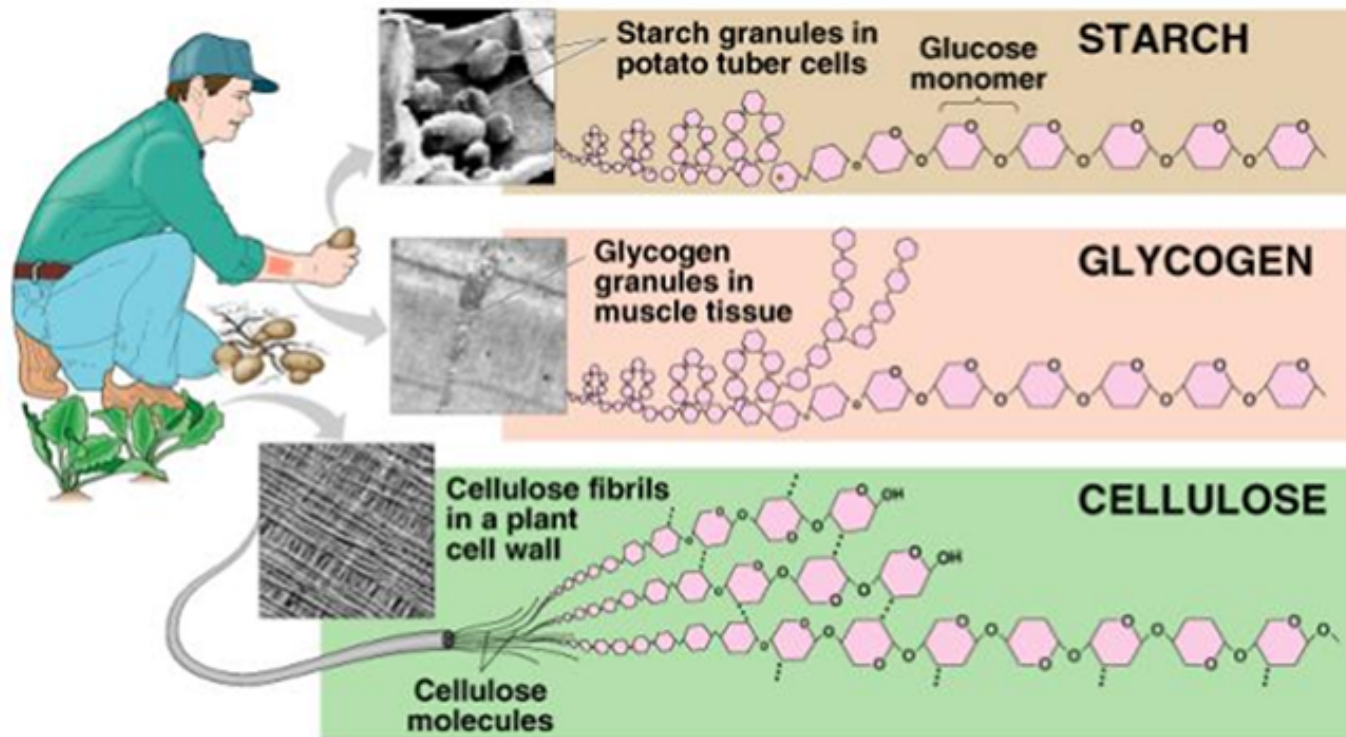


Glycogen in Liver cells



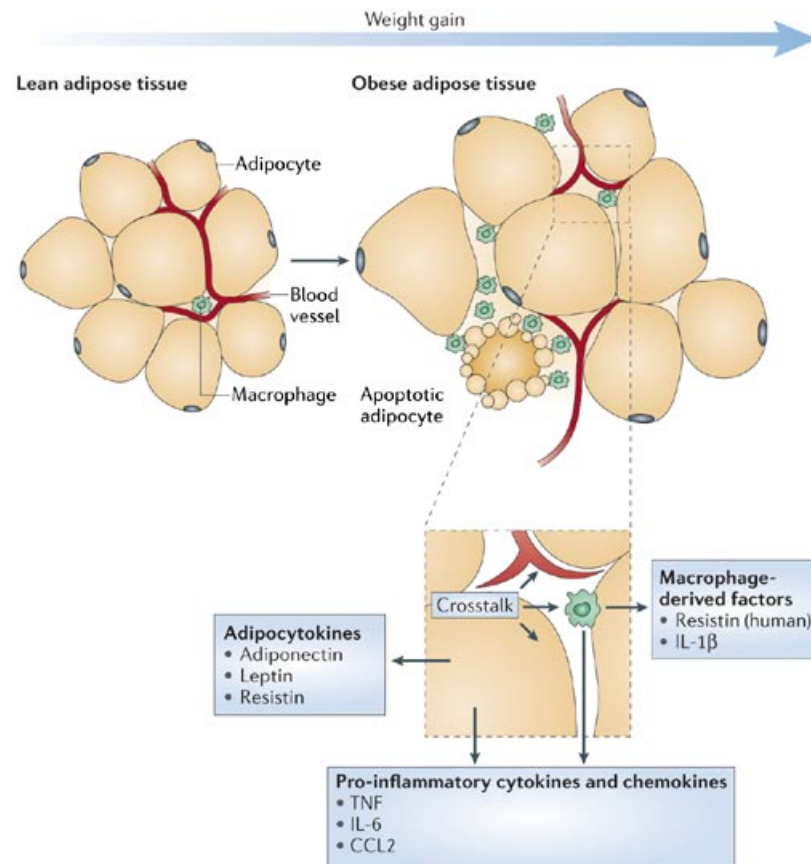
Lipids in Liver cells

# Examples of Polysaccharides

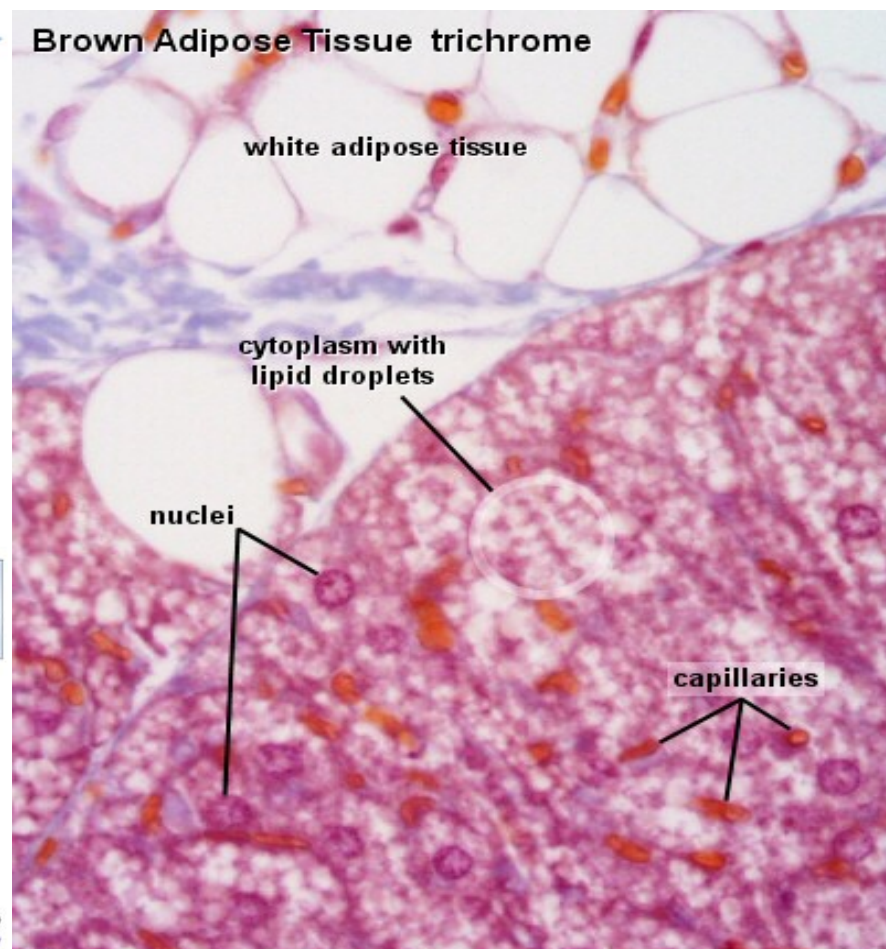


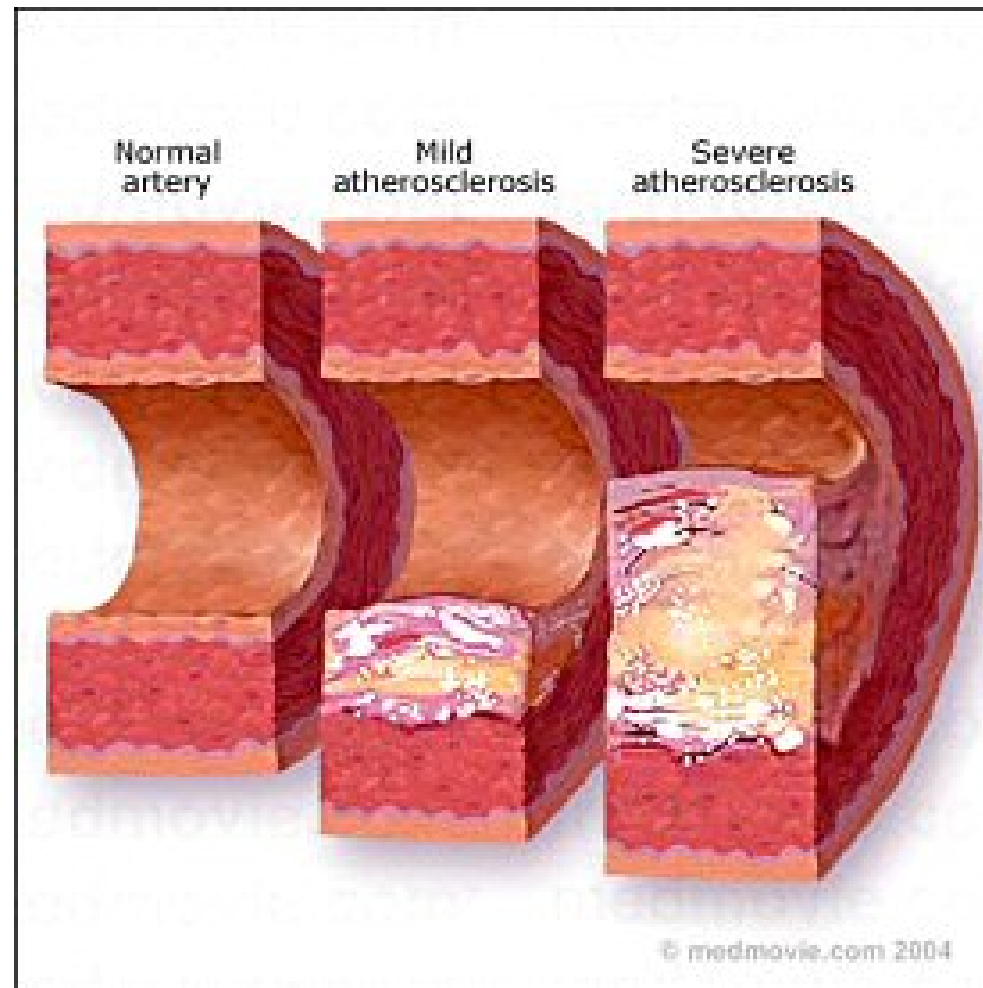
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# Objectives

## General

- Describes the structures and functions of DNA and Proteins.
- Analyzes the connection of structure and function in DNA and Proteins.

**Note:** *All, or most, of the objectives will be covered during class time, however the student must be responsible for those objectives not covered or concluded.*

# BACK

# Link and Learn

You can visit the following websites to improve your understanding on the present topic:

- <http://goo.gl/KCy95>
- <http://goo.gl/1MkZ1>
- <http://goo.gl/78x0p>
- <http://science-altair.wikispaces.com>
- <http://learningandscience.blogspot.com>

# BACK



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## BACK